Test Edition

SINDH TEXTBOOK BOARD

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Preface

It is a matter of great pleasure and satisfaction for me to iterate that the Sindh Textbook Board has been providing the students of the entire Sindh province, with textbooks of worthy standard from the point of its inception, till now. On one hand, these books are quite affordable; on the other hand, their publication and availability is being managed in a timely and efficient manner.

The main ideology behind these textbooks is that they must contain knowledgeable, qualitative material in order to impart in ours students, the skills that can help them compete in today's ever changing and challenging world. The present global scenario demands that first and foremost, our new generation must be well conversant with the Islamic ideology; then it must possess an exemplary character, a high degree of patriotism, and a sense of responsibility, brotherhood, fraternity and equality. The possession of all these qualities will assist them in their studies in general. However, acquisition of these skills is all the more important particularity in science teaching and learning, if the students are to actively participate in new scientific research and inventions, and develop awareness, soundness of mind and a progressive mind set.

Our students will be able to achieve success and economical stability and lead a prosperous and successful life, only when they are able to master these skills. Along with these skills our students will have to develop inquiry, communication, critical thinking and problem solving skills for a bright future. Having a bright future, they will be able to ultimately hold the reins of their country and provide it the much needed prosperity and economic soundness. They will become model citizens of their country and nation in shape of learners, implementers and innovators.

With objectives and intentions of such noble national spirit, the Sindh Textbook Board is introducing this book of "Science Grade-6" for new entrants in the field of education. This book has been written by well-experienced authors and reviewed by senior educationists in accordance with the "New Curriculum 2006" for inclusion in the syllabus. Thus, the Sindh Textbook Board is quite hopeful that the teachers, students and other respective stakeholders will benefit from this book.

Lastly, it is requested that in case there are any concrete recommendations(s)/suggestions from your side with reference to the material contained in this book, feel free to convey them to us, so that they can be incorporated in the subsequent edition.

The Chairman
The Sindh Textbook Board, Jamshoro.

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1 CELLULAR ORGANIZATION OF PLANTS AND ANIMALS

Have you ever thought what are we made up of? What are the basic units of all living things? What is the difference between plants and animals?

Does this creature look like a living thing? What is the basic unit of this creature? Is it made up of single material?

In this Chapter you will learn about:

- Cell
- Microscope
- Animal and Plant Cells
- Unicellular and Multicellular Organisms
- Tissues
- Plant and Animal Tissues
- Organs
- Plant (Leaf and Flower) and Human Organs (Liver, Lungs and Heart)
- Introduction to Plant Systems (Root & Shoot System) and Major Human Systems (Digestive, Respiratory, Circulatory, Excretory, Nervous Systems)

All the students will be able to:

- ✓ Define cell.
- ✓ Describe the different parts of a light microscope and how it works.
- ✓ Identify different kinds of cells using a microscope.
- ✓ Draw, label and describe the basic structure of an animal cell and a plant cell.
- ✓ Compare and contrast an animal cell with a plant cell.
- ✓ State the function of each part of the cell to indicate how the cell supports life.
- ✓ Differentiate between unicellular and multicellular organisms.
- ✓ Distinguish between tissues and organs.
- ✓ State the functions of the major systems of the human body.
- ✓ Recognize root and shoot systems in plants.
- ✓ Describe the cellular hierarchy from cell to organ systems in animals and plants.

INVESTIGATE

Who am I? Can you guess me? Without me your body can't be formed.

CELL

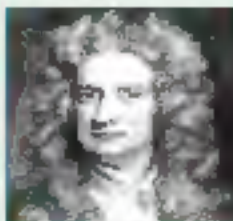
✔ Define Cell.

Do you know? What are we made of?

We see living things all around us. They have different sizes, characteristics and shapes, but they have one thing in common. The common thing is that all living things are made of cells.

Do non-living things also have cells?

Do you know?

Robert Hooke was the first scientist who observed the cell in a piece of cork in 1665.

In the previous class you have studied the needs, characteristics and classification of living things. You have also studied that some living things cannot be seen by our naked eyes, called microorganisms. Now we will study what is the basic unit of all living things. Based on various observations, scientists have concluded that all living things are made up of one or many small living units called cells. A cell is the basic unit of all living things. It is the smallest part of a living thing in which many activities take place to keep a living thing alive.

Unscramble the given word
OSEMRPICCO

\- - - - - - - - - -

HINT:
An instrument used to increase the size of the object.

The term cell comes from the word cells of a honey comb. Cells are basic units of all living things.

Cells of a honey comb

Cells of a plant

Do you find any common characteristics between these two cells?

MICROSCOPE

✓Describe the different parts of a light microscope and it works.

✓Identify different kinds of cells using a microscope.

CELL EXPLORATION

Can you name five microorganisms?

Ahmed is confused. He grows a potted plant in a garden. After few days he observed that there were many small black spots on the leaves. He wants to find out who damaged the leaves of the plant. But there were no visible worms on the leaves. Next day Ahmed discusses this problem with the teacher. Teacher explained that there are small living worms on the leaves that cannot be seen by our naked eyes but we can see them by using a magnifying glass.

Cells are very tiny and can only be seen with a microscope. If you want to know what lies inside the cells, for this firstly you should know what the main parts of light microscope are, and how can we use it to view inside the cells.

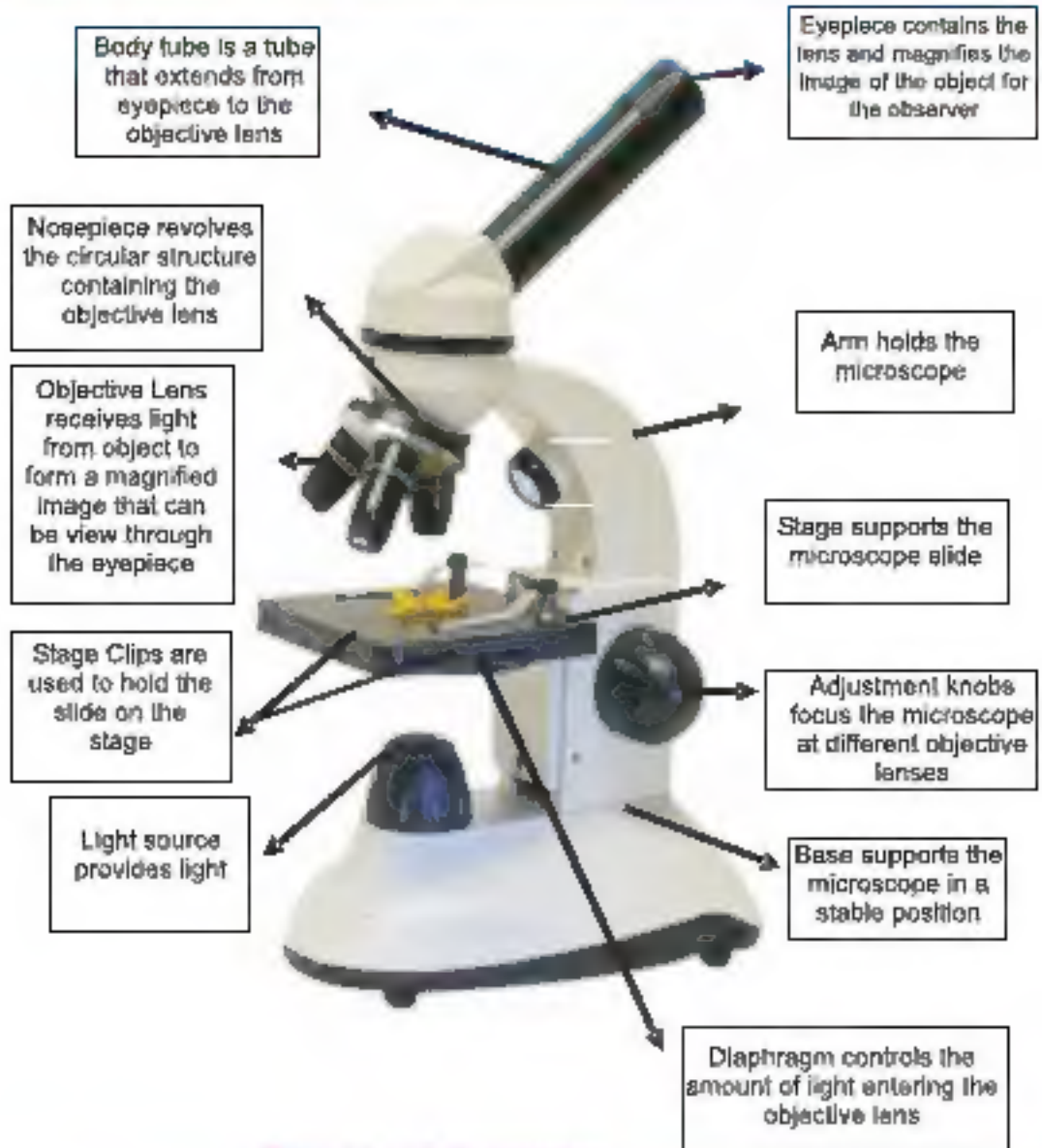



Figure 1.1. A light microscope

Activity.1: Visit your school garden. Take the gardener's help to collect samples of leaves, roots, small worms and insects. Observe these samples under the microscope/ lens.

Figure 1.2: A group of students taking samples

What I need:

- School garden
- Light microscope / lens.

What to do:

1. Observe in your school garden.
2. Observe how many different types of living things in your school garden.

Your teacher will form groups of three students in a team.

1. Ask each member to observe and record physical characteristics of the sample from the garden. Then draw the picture of sample.
2. With the help of your teacher observe the sample under the microscope / lens.
3. Draw the picture of sample that you observed under the microscope / lens.
4. Now share the differences that you find in the sample first without observing under the microscope / lens and then with the microscope / lens, along with your group members.

Teacher Note: The teacher needs to arrange the microscope / lens and discuss with students the handling of the microscope / lens. Also explain that we can easily identify different kinds of cells through microscope / lens. Teacher will prepare the sample of the leaf. Teacher also help students to correctly draw the pictures that they observed under the microscope / lens.

What I observed:

Team members	Write the name of one sample taken from the School garden here.	Observe the sample and draw what it looks like without a microscope / lens?	Observe the same sample under the microscope / lens and draw what it looks like under a microscope / lens?

Activity.2: Teacher will make use of prepared slides of different kinds of cell and ask students to observe slides with and without microscope / lens.

Activity Questions:

1. What could you observe in the sample, what difference did you find in the sample, under the microscope / lens that you did not find when you observed with your naked eye?
2. Are the cells of all the samples visible under the microscope / lens?
3. Are the cells of all samples similar in structure and shape?
4. Mention any two common differences that you observed among all cells.

Unscramble the given word
EGLAA

HINT:
The biological name of unicellular plants.

What I Conclude:

....

....

✓Draw, label and describe the basic structure of an animal cell and a plant cell.
✓Compare and contrast an animal cell with a plant cell.
✓State the function of each part of the cell to indicate how the cell supports life

Do you know?

The inside of the cell resembles a chemical factory. It brings in materials like sugar and salt and uses these materials to make new substances which the cell can either use itself or send elsewhere in the body

Observe these pictures of cells

Are they both having similar shape and structures? Do you find any differences between them? What are the differences?

Is it a plant cell or is it an animal cell? What's inside an Animal Cell? What's inside a Plant Cell?
Cheek cells show animal cell. Onion cells represent plant cell. Animal and plant cells share many characteristics but there are also some unique differences between these two cells

Observe and share similarities and differences with your class fellows

CELL EXPLORATION

Are apple cells different from frog cells?

Teacher Note The teacher should help to prepare the slides of onion and cheek cell. Also ask students questions during observation. Teacher also helps students to correctly draw the microscopic pictures of these cells in their notebook

Inside a typical animal cell

The properties and functions of the main parts of an animal cells are discussed below:

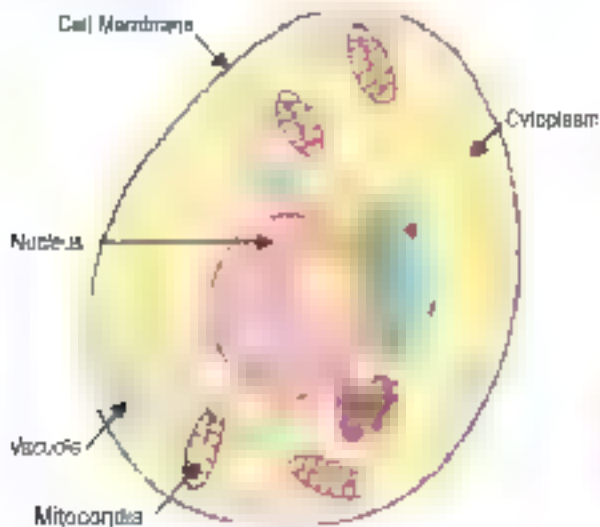



Figure 1.3: Animal cell

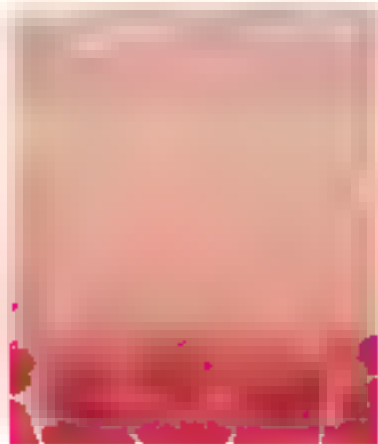
Cell Membrane: It is a thin partially permeable layer around the cell. Being partially permeable, it only allows some substances to pass through it but stops others.

Cytoplasm: It is a jelly like substance which fills up the cell and contains many chemicals. Hence many chemical reactions take place in it. It also contains vacuoles and nucleus.

Vacuoles: These are spaces containing air, liquid or food particles found in the cytoplasm. These vacuoles are small and numerous.

Nucleus: It controls all the chemical reaction of the cells. It contains chromosomes.

Chromosomes: These are thread-like materials that are passed down from parents to their offspring. They store chemical instructions needed to build the cell and control its functions.

The cells in the outermost layer of our skin are dead. Thousands of tiny fragments of the skin are lost every day. Every time you run your finger on a dusty table, you shed a lot of old skin.

The cells in all animals have almost same size. For example both elephant and mouse have similar cell size, but the number of cells in elephant is greater than mouse, which makes an elephant huge and a mouse small.

Inside a typical plant cell

Plant cells also consist of a cell membrane, nucleus, vacuole and cytoplasm like an animal cell. Their properties and functions in a plant cell are similar to those in an animal cell. But they have some certain distinctive features which differ from those found in animal cells. The properties and functions of the distinctive parts are given below:

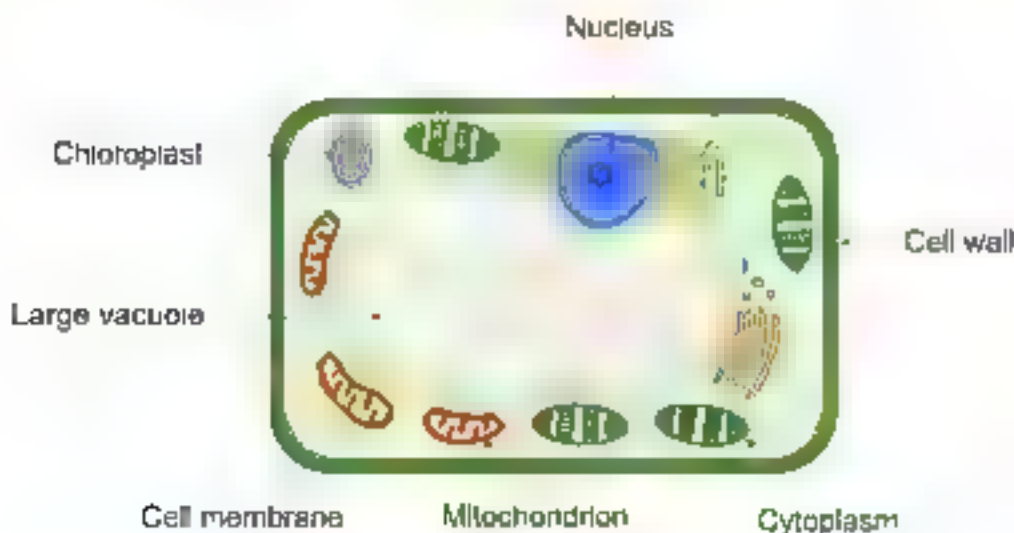



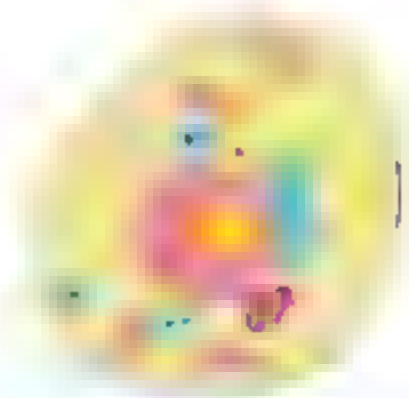
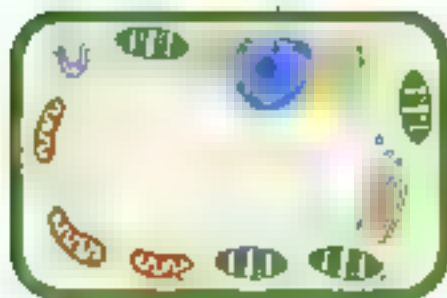
Figure 1.4 Plant cell

Chloroplast: These are tiny discs containing a green substance called chlorophyll. Chlorophyll traps the sunlight that plants need to make food through the process of photosynthesis.

Large vacuole: It is large and forms the biggest part of the cell. It fills with cell sap which contains water and dissolved substances like sugar and salt. The cell sap makes a plant cell firm by taking in water.

Cell wall: It is a thick permeable layer around the cell. Being permeable, it allows all substances to pass through it. It is made up of a tough substance called cellulose. It supports the cell and gives it a regular shape.

How is an animal cell different from a plant cell?

You have studied about plant and animal cells. Observe the diagrams of typical plant and animal cells. By looking at the structure of their cells tell us which belong to animal cell or plant cell? Also label the diagrams.

Compare your observation with the table below

Cell Structure	Plant Cell	Animal Cell
Chloroplasts		
Vacuoles		
Cell wall		
Cytoplasm		

Following are the common differences between plant and animal cell.

1. Plant cells have a cell wall, but animal cells do not.
2. Plant cells have chloroplasts, but animal cells do not.
3. Plant cells generally have a definite shape because the cell wall is more rigid.
4. Animal cells have a round or irregular shape because they do not have a cell wall.
5. Plant cells usually have one large size vacuole, but animal cells have many small vacuoles.

UNICELLULAR AND MULTICELLULAR ORGANISMS

✓ Differentiate between unicellular and multicellular organisms

Unscramble the given word
M A A O E B

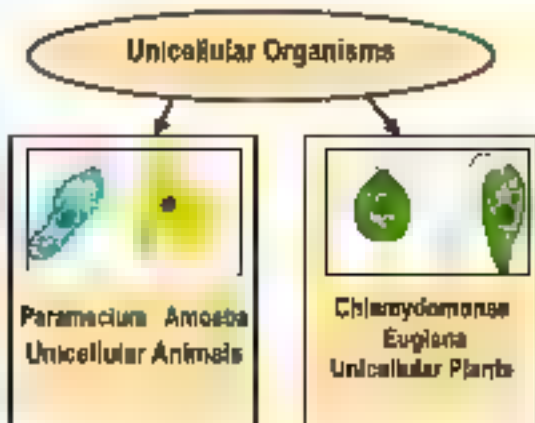
HINT:
The biological name of unicellular animals.

In the previous class you have studied the microorganisms. Do you remember how many cells does a single microorganism have? Are the number of cells in a human, similar to that of microorganisms? Microorganisms usually consist of one cell. An organism which consists of only one cell is called unicellular organism.

Many plants and animals are made up of more than one cell. An organism which is made up of more than one cell is called multicellular organisms.

Unicellular organisms are usually found in water i.e. ponds, lakes, rivers and sea, or on moist areas like tree trunks and in the soil.

Unicellular organisms have the ability to perform all necessary life processes for survival such as moving about, feeding and respiring.

Unicellular organisms are smaller in size and also lack the organized structure of cells.

Multicellular organisms are generally bigger than unicellular organisms.

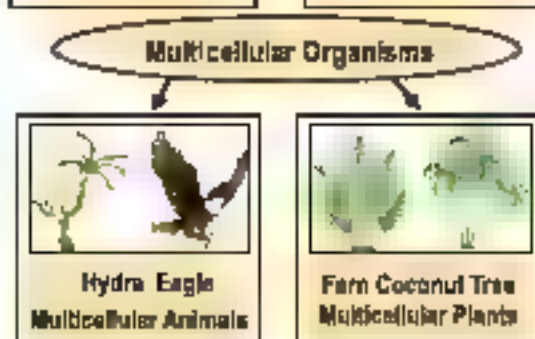
Being multicellular, each type of cell has a special job to do. This makes the cells more organized.

Multicellular organisms have different types of cells.

Multicellular organisms are found in water (hydra, fish), as well as on land (eagle, fern, coconut tree).

Multicellular Organisms

Hydra Eagle
Multicellular Animals

Fern Coconut Tree
Multicellular Plants

Teacher Note: The teacher should show the permanent slides of amoeba, hydra, euglena, paramecium and chlamydomonas. Also ask students questions during observation.

TISSUES AND ORGANS

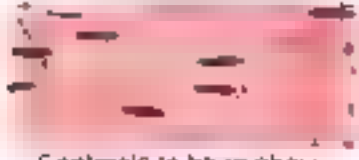
- ✓ Distinguish between tissues and organs.
- ✓ Describe plant and animal tissues.
- ✓ Highlight the important functions of plant and animal organs

Do you want to explore my body?

From cells to tissue

Have you ever tried to think that if our body consists of billion of cells, then how are these cells united and how does each cell perform a specific job? How does a single cell develop into a complex organism?

Cells of the same type working together to perform the same job make up a tissue

Plants and animals are made up of different tissues performing different functions.

My body consists of twenty different types of cells. Some common cells are as follows

I am a nerve cell. carry messages around the body

I am a muscle cell. contracts to bring about movement.

I am a red blood cell. carry oxygen around the body

Some common examples of animal tissues and plant tissues are

ANIMAL TISSUES	Epithelial Tissue Protects the structures beneath it	Muscle Tissue Contracts to bring about movement in an animal's body
PLANT TISSUES	**Epidermal Tissue** Protects a plant against injury and prevents it from drying up	**Photosynthetic Tissue** Makes food for the plant through photosynthesis

From tissues to organs

What happens when you run fast? Do you need more energy? How does your body increase the energy? How is this energy supplied to all parts of the body? All this is possible because of the pumping organ called the heart. When more energy is required the heart starts beating fast and pumps more blood, hence more energy will be supplied to each body part. Do we have only one organ? How organs are formed?

Different tissues working together to do particular job make up an organ. Each organ is responsible for carrying out one or more functions.

The most common organs in animals are heart, lungs, liver, stomach, kidneys and brain. Each organ carries out one or more important functions for our body. For example, the heart pumps the blood around the body. Liver stores the digested food and also helps in the removal of harmful waste materials. Lungs purify the blood by absorbing oxygen and give out carbon dioxide.

CELL EXPLORATION

Feel your pulse rate. How many times does your heart beat in 1 minute?

What are the organs of the plants? Plants also have organs such as leaves, roots, stems and flowers. Leaves are also called as food factory of plant because they make food for plants. Stem supports the plant. It transports water with dissolved minerals from the roots to the leaves, also transports food from the leaves to all parts of the plants. Roots absorb the water with dissolved minerals from the soil. Flowers help in the reproduction of plant.

INTRODUCTION TO PLANT SYSTEMS AND MAJOR HUMAN SYSTEMS

- ✓ State the functions of the major systems of the human body
- ✓ Recognize root and shoot systems in plants

From organs to system

Have you ever thought what a wonderful machine our body is! We think, eat, move, listen and feel and we do all this without realizing how we do them. Just as a machine is made up of many parts, our body is made up of different systems. A system consists of a group of organs working together to perform a particular function.

There are many systems in our body. Each system has a different function but they work together like a team to keep our body fit and healthy.

Here are some examples of human systems

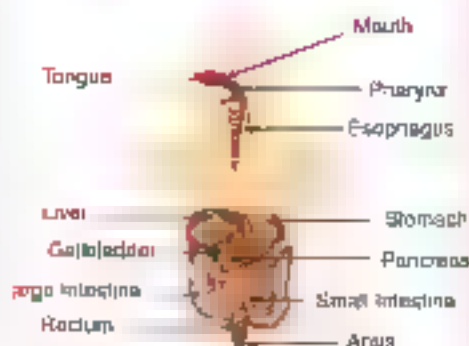
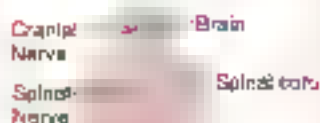



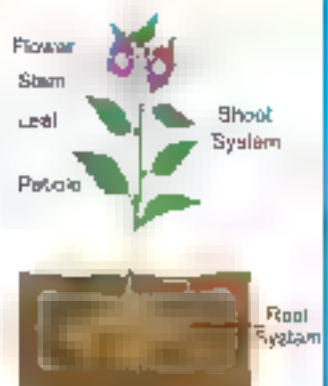
Figure 1.5 Different systems of the human body

The various systems in the body together make up an entire organism such as a human being.

Teacher Note: The teacher should use charts, diagrams or models to facilitate students understanding about different systems.

Do plants also have systems? Do you know the functions of these systems?

The whole plant is divided into two main systems i.e. root and shoot systems. Root system involves those parts that grow below the soil. It absorbs the water with dissolved minerals from the soil.

Shoot system consists of those parts that grow above the soil. It mainly includes stem, leaves, flowers, fruits and branches. It helps in the transportation of water, minerals and food.

✓ Describe the cellular hierarchy from cell to organ systems in animals and plants.

EXPLORATION

Why is the number of organ systems found in plants smaller than the number of systems found in animals?

The different systems in the body function and Coordinate their activities so that the body functions as one whole.

The cellular hierarchy from cell to organ systems in plants are shown in the figure below:

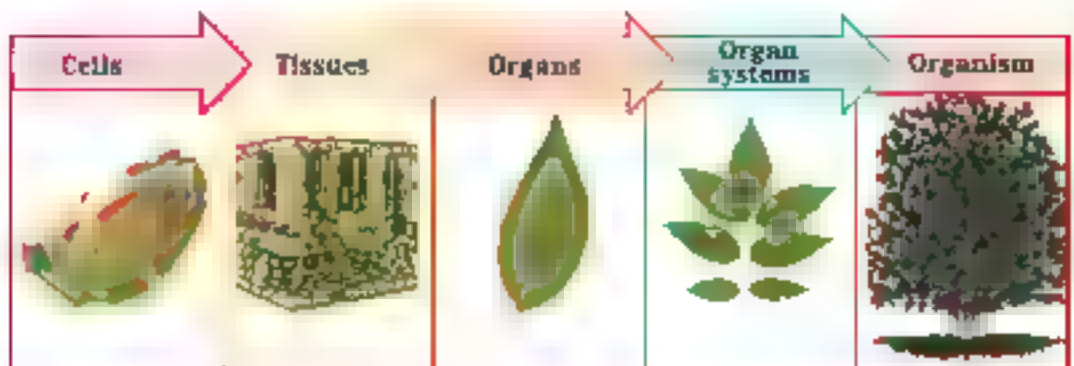



Figure 1.6: Cellular hierarchy of plants

The multicellular animal like human being is organized as shown in the figure below

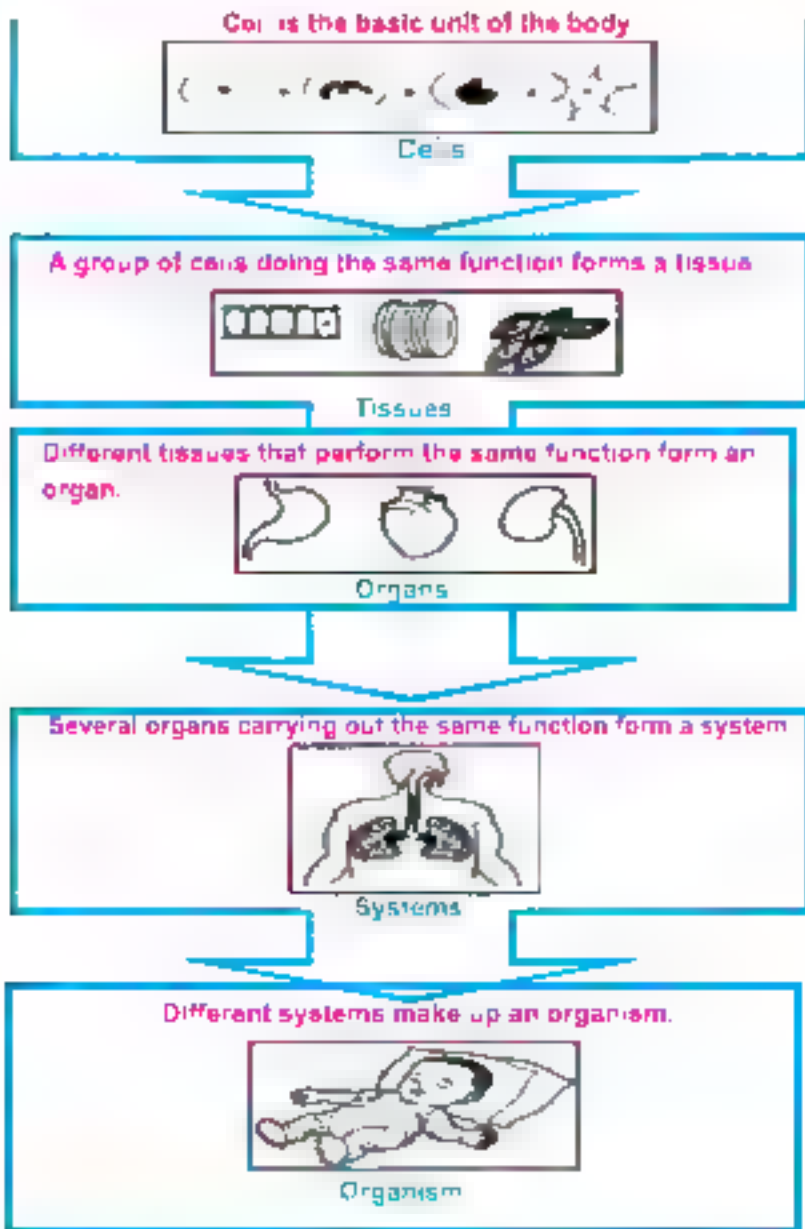



Figure 1.7 Cellular hierarchy of animals

SUMMARY

Unicellular Organism
Multicellular Organism
consists of one cell
consists of many cells
Microscope is used to see the cell
CELL
Join
Tissue
Join together
Organ
Join together
System
Join together
Organism
Types of Cells
Plant Cell
Animal Cell
Consists of:
Cell wall
Cell membrane
Cytoplasm
Large vacuole
Nucleus
Chromosomes
Chloroplast
Consists of
Cell membrane
Cytoplasm
Small vacuole
Nucleus
Chromosomes

Review Questions

1. **Circle T for True and F for False Statements**

a	The waste materials are removed through nervous system	T	F
b	Hydra is a unicellular animal.	T	F
c	Objective lens is used to focus and enlarge the specimen.	T	F
d	Chromosomes passed down from parents to their offspring	T	F
e	A system consists of a group of tissues working together to perform a particular function.	T	F

2. **Circle the best answer**

Which one of the following substances traps sunlight?

a Cellulose
b Chlorophyll
c) Cytoplasm
d Cell sap

Which row incorrectly shows the difference between plant and animal cell?

	Animal Cell	Plant Cell
a)	It does not contain chloroplast	It contains chloroplast
b)	It has many small vacuoles	It has one large vacuole
c)	It has a thin lining of cytoplasm	Most of the space is filled with cytoplasm
d)	It has only one layer i.e. cell membrane	It has two layers i.e. cell wall and cell membrane

3. **Give brief answer to the following questions.**

i Why do scientists use microscope?
ii Define the following terms with examples
(a) Multicellular organism (b) Organ
iii Why are cells called the building blocks of life?
iv Draw a flow chart to show the cellular hierarchy from cell to organ systems like digestive system in human

SENSE ORGANS

How do you know about the colour of the things around you? How do you know that the toffee is sweet and the cough syrup is bitter? How do you come to know when somebody calls your name? How do we feel hot, cold, pain or pressure? How does our body detect the wonderful smells of different kinds of foods?

Figure 2.1 A girl touching her nose

In this chapter you will learn about:

- The sense organs, eyes, ears, nose, tongue and skin

All the students will be able to:

- ✓ Explain the structure and function of nose, tongue, ear, eye and skin.

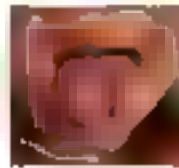
Close your eyes and touch your nose. Are you able to do so? Your body knows where your nose is even when you cannot see it.

SENSE ORGANS

✓ Explain the structure and function of nose tongue,ear eye and skin

Do you know how many sense organs you have? Complex multicellular organisms such as human beings have five major sense organs. Their names are as follows

1. Eyes 2. Ears 3. Tongue 4. Nose 5. Skin

Some sense organs contain only one kind of receptors that detect only one kind of stimuli. Others contain more than one kind of receptors, each sensitive to a particular kind of stimulus. Let us study each sense organ in detail and learn about its structure and the kind of stimulus it detects.

EYE

Eye is the sense organ of vision or sight. It contains receptors that detect light stimulus in the environment. Do you know that an object can be seen because the reflected light that comes from it, enters our eye and an image is formed. The different parts of the eye work to form an image.

Major Parts of the human eye

Cornea is the main bulging surface of the eye. Its job is to bend the incoming light towards the inner structure of the eye called the lens.

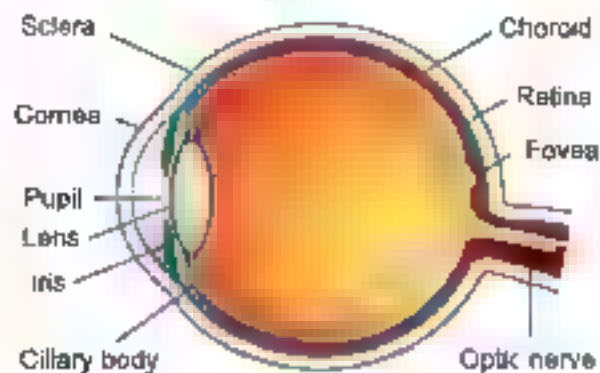
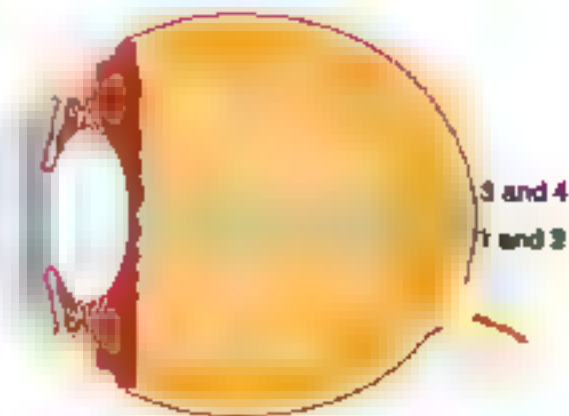
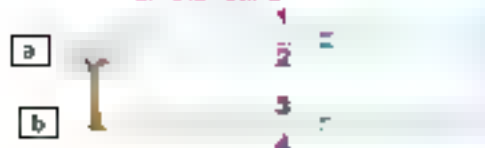



Figure 2.2: Parts of the human eye

Iris and pupil the coloured part of the eye is called iris. The iris has a central opening which allows light to enter the eye. Thus central opening is called pupil.
Lens behind the iris is the lens. It is just like the lens of camera and focuses light. Focussing allows all light rays entering the eye to meet at one single point.
Retina is the screen of the eye. All the rays of light entering the eye are focussed by the lens onto the retina. Retina has two types of light sensitive receptors also called **photoreceptors**. Rods are sensitive to light.
Optic nerve transfers the visual information from the retina to the area of the brain that interprets visual information. It carries this information as electrical signals. Optic nerve is made up of thousands of sensory neurons.

Figure 2.3: Shows how light is focused on the retina

Focussing allows all parallel light rays striking lens to meet at one single point on retina

Ray 1 and 2 coming from point (a) are focussed by the lens on one point on the retina. Similarly rays 3 and 4 coming from point (b) are focussed by the lens at another point on the retina. The focussed light rays stimulate light receptors on the retina.

How does the eye function?

When light strikes either the rods or the cones of the retina it's converted into an electric signal. The signal is sent to the brain via the optic nerve. The brain then translates the electrical signals into the images we see

Technology corner Use of technology to correct vision impairment

How often do you see people wearing eye glasses? Eye glasses are a common sight You also know that they are used to correct vision for those who are unable to see properly other wise

When person's vision is impaired the eye lens does not work properly. The image of an object does not form on his retina The image is either formed in front of the retina or behind it Eye glasses use another lens, with the help of which. the eye is again able to form an image on the retina

Contact lenses are a similar technology They can be worn inside the eyes

A more recent technology is laser treatment to correct vision

EAR

You already know Ear is the sense organ of hearing It contains receptor for sound stimulus

Parts of the ear The ear is made up of three parts the outer middle and inner ear All three parts of the ear are important for detecting sound by working together to move sound from the outer part through the middle and into the inner part of the ear

The outer ear The outer part of the ear that we see collects sounds. It is called pinna The outer ear also contains the ear canal. The ear canal transfers sounds from outer ear to the middle ear

The middle ear It consists of an ear drum and three small bones. The main job of all these is to convert the sound waves into mechanical vibrations When a sound waves reaches the eardrum. It causes vibrations of the ear drum, which results in the vibration of the three small bones **malleus incus** and **stapes**.

The Inner ear The inner ear contains a structure called cochlea with tiny hair like structures. The cochlea nerve carries sound information from the **cochlea** of the **inner ear** directly to the **brain**.

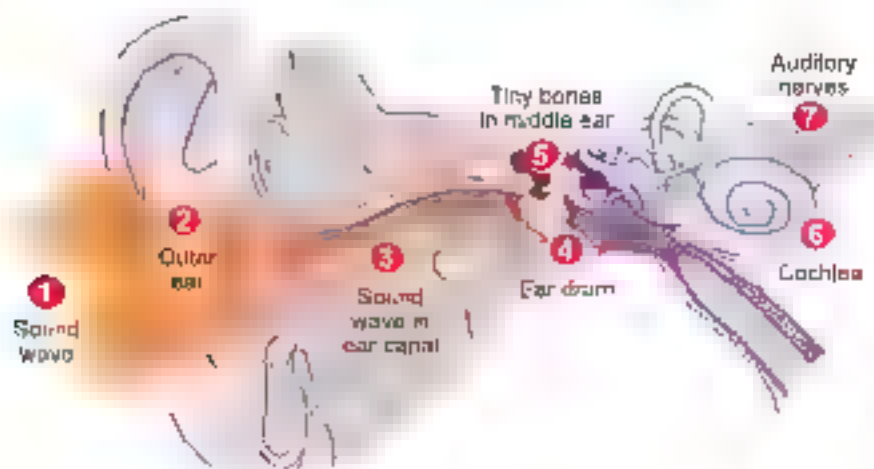
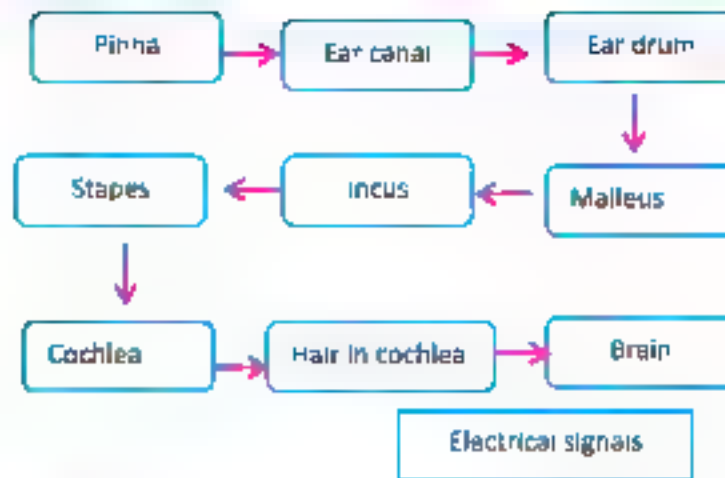



Figure 2.4 The ear and its parts

How does the ear function to process stimuli?

Vibrations in the small bones set the fluid inside the cochlea to motion. The tiny hair like structures on cochlea also starts vibrating. Their vibrations create electrical signals. These signals are sent to cochlea nerve which takes them to the brain.

Figure 2.5 The inside of the ear

Do you know that the inner ear also contains three semicircular canals which help our body keep its balance. Without the semicircular canals you would fall down if you bend down to pick up your fallen pencil.

Flow chart for the passage of sound vibrations through ear

NOSE

Nose is the sense organ for smell. All smells are actually chemicals present in air. Nose has receptors which detect certain chemical present as vapours in air.

Parts of the nose

The inside of the nose is a cavity called the **nasal cavity**.

Up on the roof of the nasal cavity are special receptors that are sensitive to odour molecules that travel through the air. There are hundreds of different odour receptors, each with the ability to sense certain odour molecule.

How does the nose function to process stimuli?

When the smell receptors are stimulated, signals travel along the olfactory nerve to the olfactory bulb. The olfactory bulb is the part of the brain that receives signals from odour receptors.

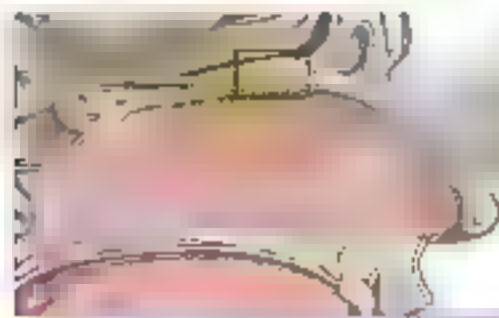



Figure 7.6 The receptor inside the nasal cavity

Tongue

Tongue is the sense organ for taste. It has receptors which are sensitive to chemicals present in food. Some of these taste receptors are also present on the roof of mouth. The receptors in tongue can taste four basic kinds of tastes salt, sweet, sour and bitter.

Structure of the tongue

The tongue is a muscular organ. The rough surface of the tongue is due to structures called papillae. In between the papillae, taste buds containing many taste receptors are present. Each of these taste receptor cells has hair like structures. The hair like structure is connected to a sensory nerve that runs to the brain.

Figure 2.7: The surface of the tongue

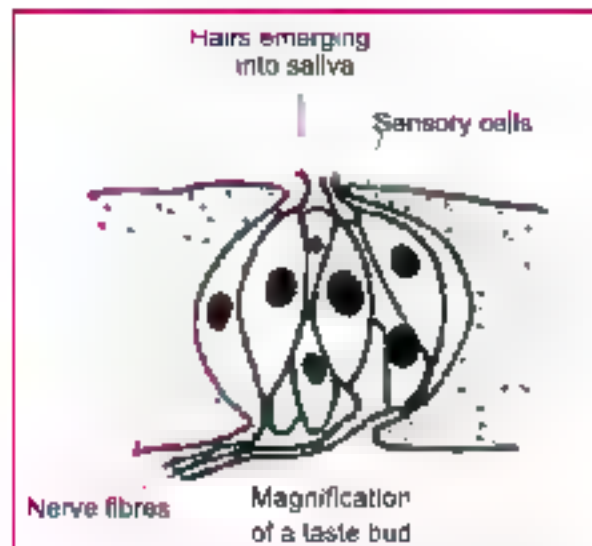



Figure 2.8: Magnified image of a taste bud

How does the tongue function to process stimuli ?

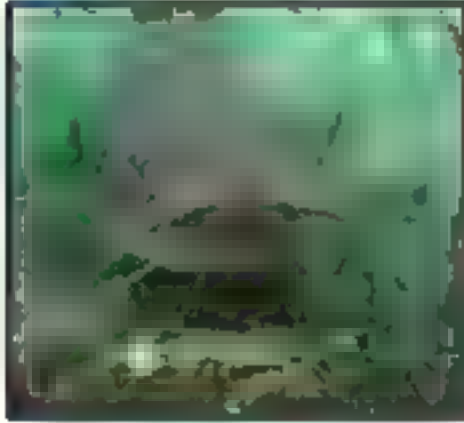
When chemicals in food come in contact with the receptor cells in taste buds, an electrical signal is transmitted to the brain via the sensory nerves.

Do you know that a cat fish has taste receptor spread all over its body? This enables it to detect its prey.

Figure 2.9: A catfish

SKIN

Skin has receptors sensitive to touch, temperature, pain and pressure. Thus it senses touch or contact, pressure, pain and hotness or coldness.

Structure of the skin

The outer layer of the skin is very thin called epidermis. Under the epidermis is a layer called dermis. Dermis contains structures that detect specific stimuli. Inside the dermis there are sense receptors that can sense pain, heat and cold and are sensitive to light and touch.

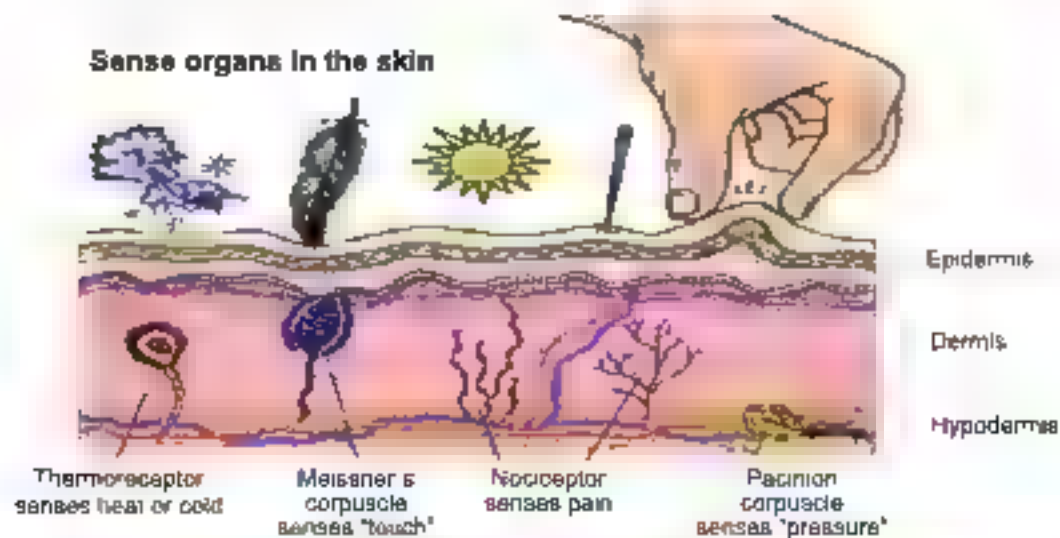



Figure 2.10: Inside of the skin and its receptors

How does the skin function to process stimuli?

The receptors in skin are connected via sensory neurons to the brain. When a receptor is stimulated, electrical signals are sent via these neurons to the brain.

Activity 1 Are all areas of skin equally sensitive to touch?

What do you need?

- A paper clip
- A volunteer
- A blindfold

What to do?

1. Open the paperclip such that the two pointed ends are almost a centimetre apart.
2. Blindfold your partner. Tell your volunteer partner that you will lightly poke him/her on different areas on the skin. He/she has to tell whether he feels one poke or two pokes.
3. Without telling your partner, poke him/her on different areas of skin. Ask him if he feels one or two pokes. Record the observation in the following table.

What did you observe?

Area of skin	Actual number of pokes	Number of pokes felt
Tip of finger		
Palm of hand		
Back of hand		
Foot		

Activity questions

Touch your forehead with the front and back of your hand. Do you think both skin surfaces detect the temperature similarly?

Sense with type of stimuli

Sense organ	Type of stimuli detected
eyes	light
ears	sound
nose	Chemicals present in air
tongue	Chemicals present in food
skin	Hotness, coolness, pain and contact

Teacher Note: Assist children in forming groups and working with each other.

SUMMARY
Sense organs
Basic organization
Human sense organs
Receptor cells that detect stimuli
Sensory neurons that transmit electrical signals to brain
Eye
Contains cornea, iris, pupil, lens, retina and optic nerve
Receptors sensitive to light are located in retina
Nose
Contains a nasal cavity with olfactory epithelium
Smell receptors are located in the olfactory epithelium
Skin
Three layers epidermis, dermis and fat layer
Receptors for heat, and pain
Ear
Contains pinna, ear drum, ossicles cochlea, semicircular canals, cochlear nerve
Receptors sensitive to sound are located in cochlea
Tongue
Contains taste buds
Receptors cells are present in taste buds

Q.1 Fill in the blanks.

a The ability of living organisms to detect stimuli is called ______________

b A ______________ is a cellular structure that can detect a specific stimulus.

c A _______ is any change in organism's environment that can be sensed or detected.

d Our tongue can detect four types of tastes namely ______________, ______________, ______________

Q.2 Circle T for True and F for False Statements

a Besides the tongue, taste receptors are also located along the roof of the mouth. T/F

b Receptors sensitive to light are located in the cornea of the eye. T/F

c The region of brain that receives smell sensations is called olfactory bulb T/F

d Eye is a sense organ of sight and balance. T/F

Q.3 Each of the following is a stimulus

A pin prick, a cool gush of wind, your teacher's voice, the fragrance of a perfume and a hand shake

a Which of the above is a pain stimulus? Which sense organ detects it?

b Which of the above is a temperature stimulus? Which sense organ detects it?

c Which of the above is a smell stimulus? Which sense organ detects it?

d Which of the above is sound stimulus? Which sense organ detects it?

e Which of the above is a touch stimulus? Which sense organ detects it?

Q. 4. (a) Show how the sound stimulus is processed from the air into the brain by drawing a flowchart.

(b) Draw a neat and labelled diagram of the human ear

Q5 To which sense organ does each of the following structures belong?

Cochlea	
Retina	
Lens	
Malleus	
Olfactory epithelium	
Tactile corpuscle	
Dermis	

Q6. Where is each of the following structures located in the body? What job does each perform?

Pinna	
Lens of the eye	
Ear drum	
Smell receptors	
Taste buds	

Q7 Describe in your own words how a sense organ works

Q8 Write a note on the structure and function of human eye as a sense organ.

PHOTOSYNTHESIS AND RESPIRATION IN PLANTS

Why are plants important? How do plants get their food? Which part of the plant is important for the synthesis of food? Where does respiration take place in plants?

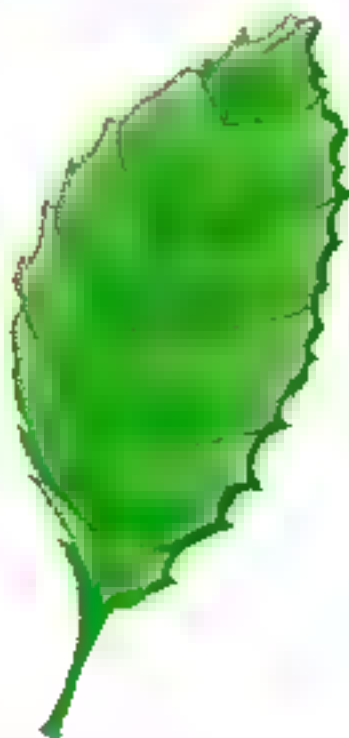



Figure 3.1 A leaf

Are you aware of the importance of this part of the plant? How does shape of leaves help them to do their job?

- Internal structure of a plant leaf
- Photosynthesis
- Benefits of photosynthesis
- Factors necessary for photosynthesis (Water Carbon di-oxide, light temperature and chlorophyll)
- Respiration in plants(Process and its importance)

All the students will be able to:

- ✓ Describe the internal structure of a leaf
- ✓ Define photosynthesis.
- ✓ Explain the importance of photosynthesis in plants
- ✓ Describe the effects of different factors on the process of Photosynthesis
- ✓ Explain that how the structure of leaves facilitates photosynthesis
- ✓ Prove with the help of an experiment that photosynthesis takes place in a leaf
- ✓ Describe the effects of different factors (Water Carbon di-oxide, light temperature and chlorophyll) on the process of Photosynthesis
- ✓ Explain the importance and process of respiration in plants
- ✓ Compare and contrast the processes of photosynthesis and respiration in plants

INTERNAL STRUCTURE OF LEAF

✓Describe the internal structure of a leaf

Observe the internal structure of leaf in the picture given below

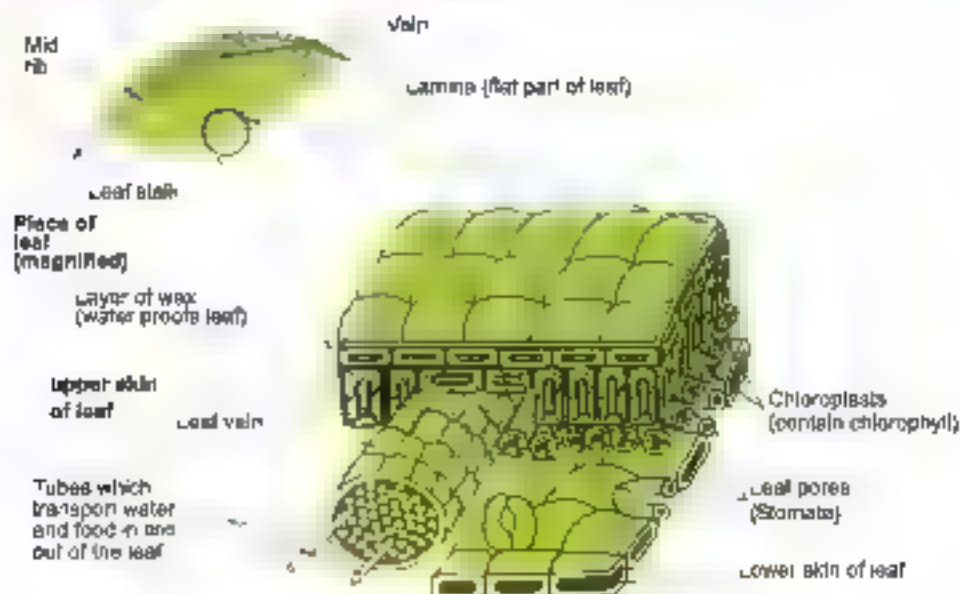



Figure 3.2: The internal structure of a leaf

Leaf is a green part of plant. Most leaves are thin and flat. Upper layer of leaves is waxy which is waterproof and it prevents the excessive loss of water from the leaf. The layer which follows the wax layer is upper skin of leaf. Under the upper skin layer there are elongated cells containing chloroplast. **Chlorophyll** is present in the chloroplast of these cells. Plants prepare their food material in these cells. So leaves are called food factories. The lower skin of leaf has more small pores called **stomata**, where the exchange of gases (Carbon di-oxide and Oxygen) takes place. Leaf veins are full of tubes. These tube cells transport water and food from and to the leaf.

Teacher Note: Teacher can help students to observe leaf cross-section under microscope. Also, teacher can engage students in discussion with the help of questions like: how can you check that upper layer of leaf is waxy? Why more stomata are present on the lower skin of leaf?

PHOTOSYNTHESIS AND ITS IMPORTANCE

- ✓ Define Photosynthesis
- ✓ Explain the importance of Photosynthesis in plants

All living organisms need food to grow and survive. Plants are known as producers because they provide food for many other organisms. Green plants are only living organisms that make their own food. What is the name of the process by which plants make their own food?

Plants make their own food by photosynthesis. The materials for photosynthesis come from the air and the soil. What are these materials called?

Photosynthesis takes place in plant cells within chloroplasts. Chloroplasts contain the green chemical called chlorophyll. Chlorophyll absorbs the energy from sunlight that allows carbon di-oxide and water to react.

The products of the reaction between carbon di-oxide and water are glucose and oxygen.

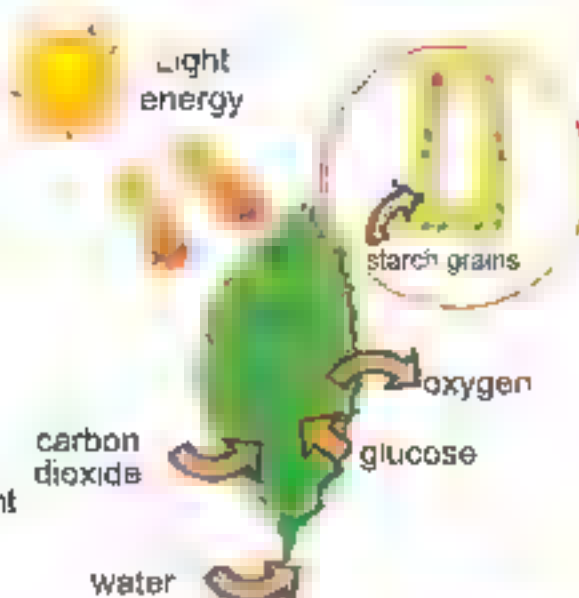
Glucose is the useful product for plants.

Some glucose is used straightaway by plant cells, some is converted to starch for storage and later used for food.

Oxygen gas is transported out of the leaf into the air.

Do you know?

The word photosynthesis comes from the Greek language:
"photo" means "light" and "synthesis" means "putting together".
Photosynthesis thus means "putting together with light".

Figure 3.3 Process of photosynthesis

Explain, how is photosynthesis important for humans and other living organisms?

Word equation of Photosynthesis

$$\text{Carbon dioxide} + \text{water} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{Glucose} + \text{Oxygen}$$

$$6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2$$

STRUCTURE OF LEAF AND PHOTOSYNTHESIS

✓ Explain how the structure of leaves facilitates Photosynthesis.

Leaves are called the most efficient solar panels on Earth. Light energy is absorbed by the chlorophyll in leaves and used to carry out **photosynthesis**. Leaves have different shapes and sizes but what features do they have in common to maximize photosynthesis? How are leaves structured to maximize photosynthesis?

Leaves are wide and flat to create large surface area and to absorb more sun light.

Leaves are wide as gases can reach easily.

Leaves have small pores called stomata to carry gases in and out.

Leaves have lots of veins to transport water and glucose.

Leaves are well structured for their functions. Their broad, flat, thin shape and large surface area aids to absorb carbon di-oxide and sunlight.

Match each feature of leaf to its fuction.

Wide and Flat	allow gases in and out
Thin	carry water into cells and extra glucose out
Stomata	allow gases reach easily
Veins	absorb more sun light and carbon di-oxide

Activity Prove with the help of an experiment that photosynthesis takes place in a leaf

Leaf can be tested that whether photosynthesis takes place or not

What I need

Fresh leaves iodine, dropper forceps. flat plate or disc, beaker, water bunsen burner or sprit lamp.

What I do.

1. Place the fresh leaf in the beaker of boiling water for about 2-3 minutes.
2. Place the leaf on plate or disc
3. Drop iodine solution on leaf
4. If there is starch in the leaf the iodine changes colour of leaf into blue-black

What I observe.

What I conclude:

Teacher Note Teacher should inquire and explain the change of colour indicates the presence of glucose molecule in the plant which has been synthesized as part of photosynthesis in the leaf

NECESSARY FACTORS FOR PHOTOSYNTHESIS

✓ Describe the effects of different factors (Water, Carbon di-oxide, light temperature and chlorophyll) on the process of Photosynthesis

Light, water, carbon di-oxide, temperature and chlorophyll are necessary factors to carry out photosynthesis.

Light

Chlorophyll, especially in leaves traps sunlight to make glucose. As light intensity (brightness) increases the rate of photosynthesis increases.

Chlorophyll

Chlorophyll is green pigment present in chloroplast of plants. It gives green colour to the leaves. Photosynthesis is possible because chlorophyll traps sunlight.

Temperature

Photosynthesis is a chemical reaction and most of the chemical reactions are temperature dependent. Photosynthesis becomes slow at above 45°C and at very cold temperature.

Water

Water is a necessary factor required to carry out photosynthesis. Plants absorb water from soil.

Carbon di-oxide

Carbon di-oxide (CO_2) is another necessary factor of photosynthesis. Plants absorb this from air.

RESPIRATION IN PLANTS (Process and Its Importance)

- ✓ Explain the importance and process of respiration in plants
- ✓ Compare and contrast the processes of photosynthesis and respiration in plants

Photosynthesis and respiration are the main pathways by which cells trap, store and release energy. Photosynthesis and respiration are interlinked.
The equation for Photosynthesis and Respiration may be summarized as.

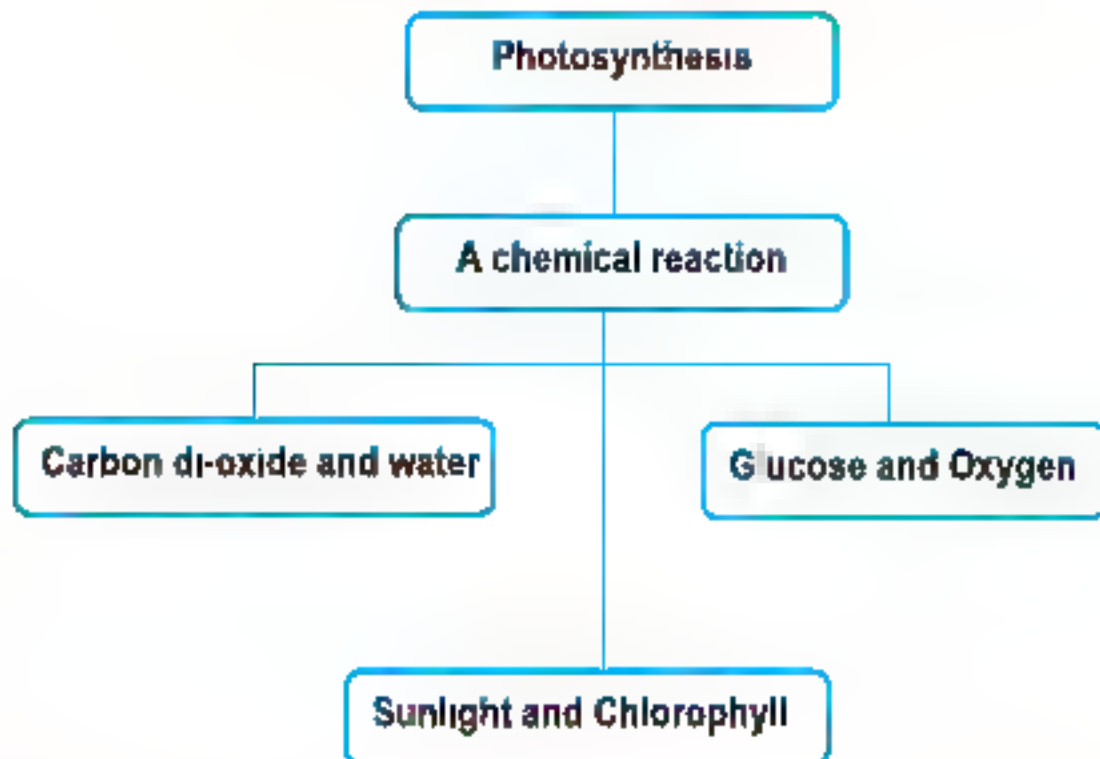
$$\underset{\text{Carbon di-oxide}}{6CO_2} + \underset{\text{Water}}{6H_2O} \xrightarrow{\text{Sunlight /Chlorophyll}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2}$$

$$\underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2} \xrightarrow{\text{Respiration}} \underset{\text{Carbon di-oxide}}{6CO_2} + \underset{\text{Water}}{6H_2O}$$

As shown in the equation Photosynthesis uses Carbon di-oxide from the atmosphere and gives out Oxygen which is opposite to exchange of gasses in respiration. When green plants respire they utilize the sugar they have produced to release energy. Generally during the day when the plants perform Photosynthesis they take in more Carbon di-oxide than they give out. At night when photosynthesis stops and respiration continues, plants give out more Carbon di-oxide but no longer take it in.

Comparing Photosynthesis and Respiration	
Photosynthesis	**Respiration**
Energy is needed in this	Energy is released in this
Occurs in plants only	Occurs in all living organism
It is food making process	It is food-using process
It traps energy to produce food (glucose)	It breaks glucose to produce energy
Carbon di-oxide is used	Carbon di-oxide is produced

SUMMARY

Photosynthesis
A chemical reaction
Carbon di-oxide and water
Glucose and Oxygen
Sunlight and Chlorophyll

Review Questions

Q1 Choose the correct option

i Stomata present in leaves help the plant in
(a) Evaporation (b) Absorption (c) Transportation

ii The green pigment present in the leaf is
(a) Chlorophyll (b) Chloroplast (c) Chromoplast

iii The material required for photosynthesis are
(a) Water and Oxygen (b) Water and carbon-di-oxide
(c) Water and sunlight

iv Photosynthesis occurs during day time because it depends on
(a) Day activities (b) Brightness (c) Sun light

v During night plants give out more
(a) Carbon di -oxide (b)Oxygen (c)Water

Q2. Answer the following questions.

a) Which part of a plant is involved in food making process?
b) What is the function of the stomata?
c) What is the Photosynthesis?
d) Photosynthesis is also of vital importance to animal why?
e) Name two important gases involved in Photosynthesis ?
f) What is the role of Chlorophyll?

Q3. Match the following

Lamina	Take in Carbon di-oxide and gave out Oxygen
Stomata	Contain Solar Panels
Root hairs	Contain small opening called Stamata
Leaf cell	Trap Solar energy
Chlorophyll	Absorbs water and mineral salt from soil

Project Ideas

- Prepare poster presentation of photosynthesis and respiration and display in your class?
- What happens if photosynthesis stops?

ENVIRONMENT AND INTERACTIONS

What kinds of living components are there in your surroundings? What kinds of non-living components are there in your surroundings? How are the living components dependent on the non-living components in their surroundings? How are plants dependent on sunlight? How are the animals dependent on plants? How are animals dependent on other animals?

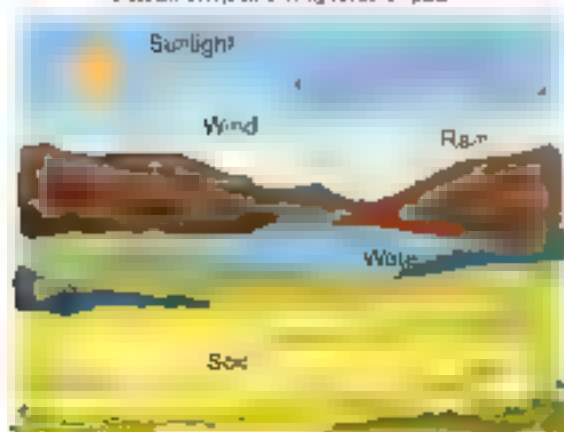
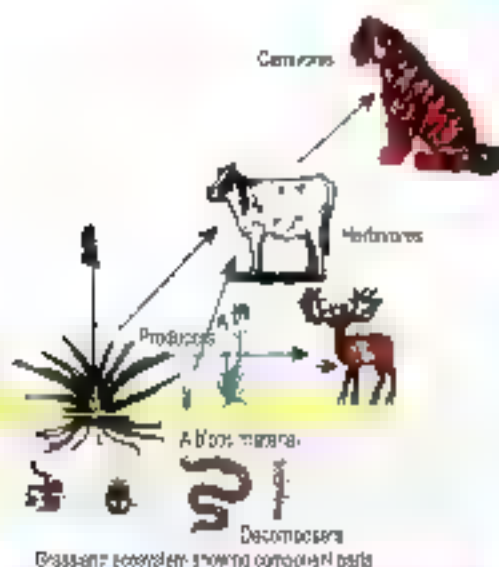



Figure 4.1 Components of the environment

- Biotic components (producers, consumers and decomposers)
- Abiotic components (light, air, soil, temperature and water)
- Relationships in organisms (predator-prey, parasitism, and mutualism)

You should be able to

- Identify the components of environment.
- Compare the physical factors, which make up the environment of a desert and a rain forest.
- Describe the relationship between biotic and abiotic components of the environment.
- Explain how abiotic factors affect the ability of plants to create their own food.
- Describe that living things depend on one another for food, shelter and protection.
- Explain the different relationships between organisms.
- Give examples of how organisms interact with each other and with nonliving parts of their environment.

BIOTIC COMPONENTS (PRODUCERS, CONSUMERS AND DECOMPOSERS)

Activity 1 Make a list of biotic components.

> ✓ Identify the components of environment.

We have studied earlier that environment is ones surrounding. All living and non-living components in your surrounding make up the environment. Do you know what biotic components are? Are you aware that the living things make up the biotic components? Look at the pictures given below and name the living things in the picture. Observe your surroundings make a list of biotic components in your surroundings. Talk to your elder siblings and peers. Draw or take photographs of biotic components in your environment.

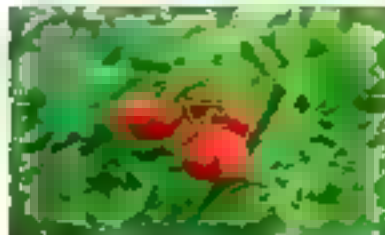
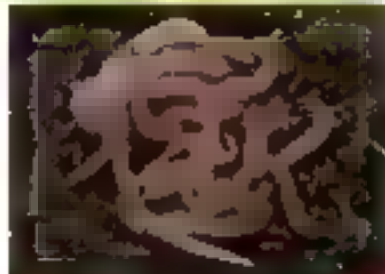
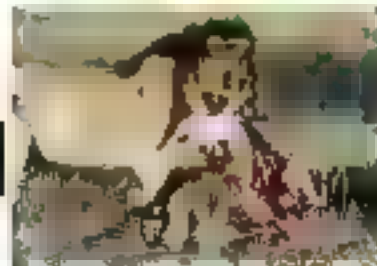
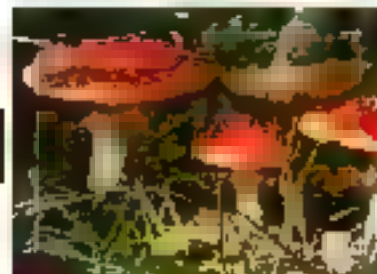



Figure 4.2: Biotic components

Teacher Note: Teacher needs to show pictures of biotic components or ask students to observe the pictures above. Ask students to make a list of biotic components by observing the picture and from their surroundings.

Biotic components are of three types

1) Producers
2) Consumers
3) Decomposers

1 Producers

The green plants, algae and some bacteria that can make their own food by using water and carbon di-oxide in the presence of sun's energy are called **producers**. You have studied earlier that plants are unique among living things in being able to make their own food. Their leaves act like solar panels. Using chemical called chlorophyll, they gather the sun's energy and set it to work in the process known Photosynthesis. This process uses light, water, and carbon di-oxide to build up, or "synthesize" important substances for plants life

2. Consumers

The animals that get their food by eating plants or other animals are called **consumers**. The consumers that eat only plant such as cow, goat, and rabbits are **primary consumers** and the consumers that eat primary consumers such as lion, dog, and wolf are called **secondary consumers**

3. Decomposers

The small animals and fungi living in the soil feed on dead decaying bodies of plant and animals are called **decomposers**. They break down complex substances in the dead bodies into simple substances. In the above process they derive energy for their own growth and reproduction. These simpler substances enter the soil again after complete decomposition of the plant and animals. From the soil the green plants absorb these substances in producing food during photosynthesis

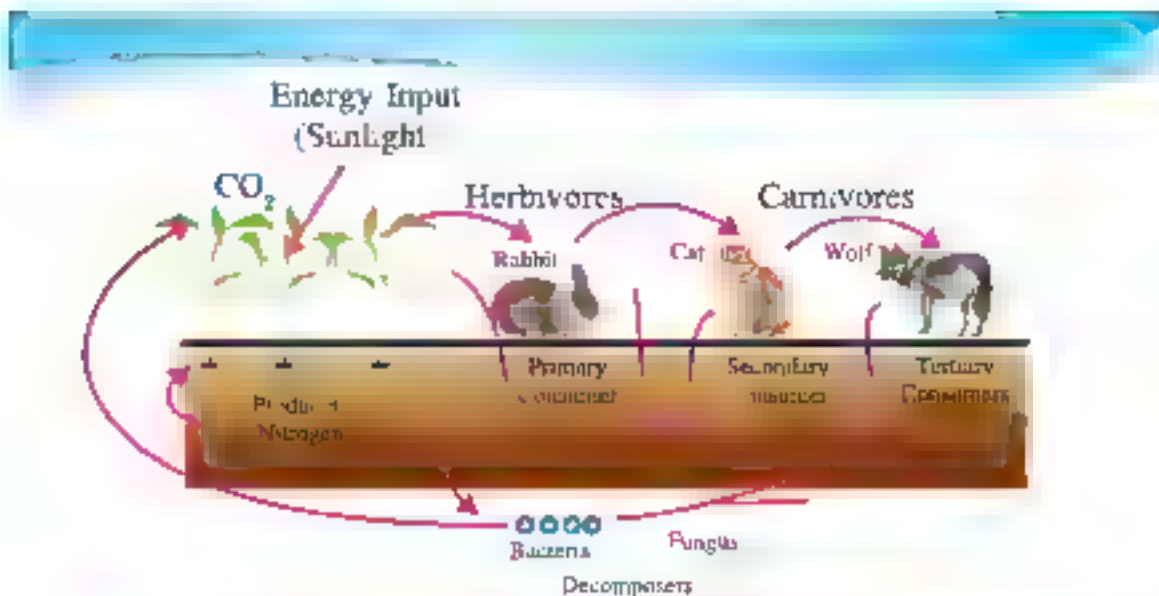



Figure 4.3: Producer, Consumer, Decomposer

ABIOTIC COMPONENTS (LIGHT, AIR, SOIL, TEMPERATURE AND WATER):-

✔ Compare the physical factors, which make up the environment of a desert and a rain forest.

Figure 4.4: Abiotic components

The environment is also made up of non-living components. These non-living components or physical factors that make up the environment are called abiotic components. Do you know what these physical factors are? These are light, air, soil, temperature and water. These physical factors are different at different places in the environment and affect the survival of biotic component in that environment.

We have studied earlier that Pakistan has various types of environments and all these environments have some unique physical features. Pakistan is blessed with all types of land, water and air environments, such as grasslands, wetlands, forests, lakes, river, sea, ocean, desserts, valleys and urban and rural environments.

We need to know the key features of these environments. For example: the physical factors in a desert environment are very different from a rain forest.

Activity 2 Listing the similarities and differences

- Observe the two environments.
- Make a list of the similarities and differences.
- Share with your class fellow.

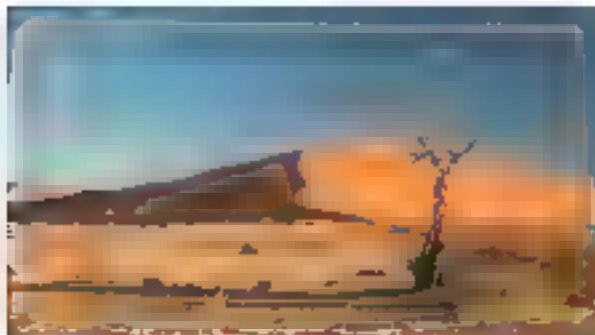



Figure 4.5: Desert

Deserts are **very hot, dry and sandy place**.

Deserts have **extreme heat, high temperature** and **dry air** and **very little rain** throughout the year.

Deserts are very hot during day time and the temperature drops sharply during the night.

Figure 4.6: Rain forest

The **Rain Forest** has warm **temperatures** and heavy **rainfall**; this makes the rain forest a home to many **trees, herbs, shrubs, plants, seedlings**, and several varieties of **birds, mammals, insects, reptiles, amphibians and small creatures**. The rainforest covers only about 6% of total Earth's surface but is home to over half to two thirds of the world's total species.

Do you know?

Wetlands are especially sensitive ecosystems

While all ecological systems in the world require protecting, the wetlands are especially sensitive to imbalance. The wetlands found in many areas of the world contain an incredibly diverse group of animals and plants. They also serve to filter the water through them extremely effectively. There are certain species of animals that are only ever found in wetlands, people must prevent deforestation from taking the wetlands away, otherwise the human race stands to lose these animals, too.

- ✓ Describe the relationship between biotic and abiotic components of the environment.
- ✓ Describe that living things depend on one another for food, shelter and protection.
- ✓ Give examples of how organisms interact with each other and with nonliving parts of their environment.

ABIOTIC COMPONENTS

The community of living organisms or biotic component (plants, animals, and microorganisms, sometimes called **biota**) in an environment interacts with non-living or abiotic components (water, air, nutrients, and solar energy) for food, shelter and protection. This community of biotic and abiotic components and their interactions for survival in the environment make up an **ecosystem.**

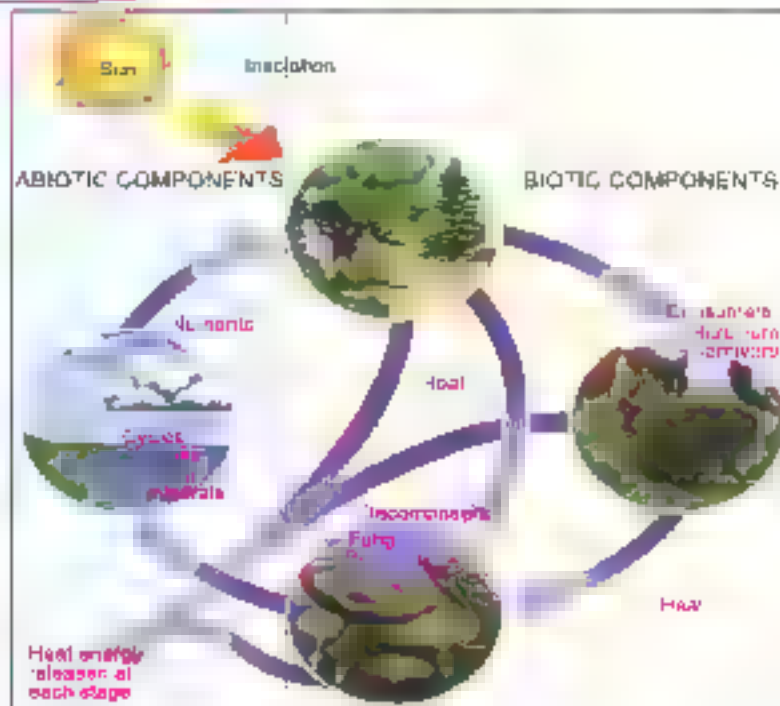



Figure 4.7 An ecosystem

There are various types of ecosystem:

- Fresh water ecosystem
- Terrestrial ecosystem
- Ocean ecosystem

As shown in the figure the interactions between biotic and abiotic components

In ecosystems help in maintaining the balance between these components and the environment. These interactions are responsible for obtaining the stability in the environment.

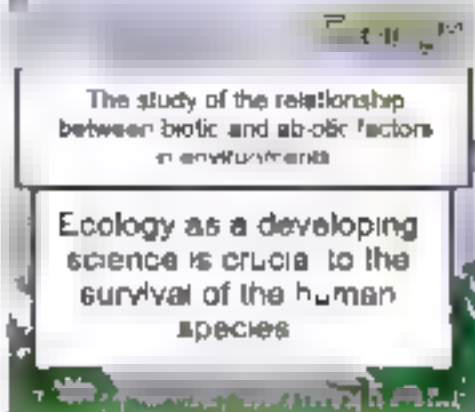
Biotic components shape an ecosystem. In a grassland ecosystem, biotic components can be categorized as producers, consumers, and decomposers. The producers capture the solar energy, use the nutrients available, and produce food. For example, grasses, trees, lichens, cyanobacteria are producer.

Consumers do not have the ability to produce or capture energy on their own and depend on the producers. They may be the herbivores, carnivores, and omnivores. Decomposers break down the dead material providing nutrients for the producers.

Insects, fungi, bacteria are examples of decomposers. In the grassland ecosystem, soil is the important link between the biotic and abiotic components.

Abiotic factors affect the living organisms in a community. In a barren ecosystem new organisms start colonizing the ecosystem. They depend on the environmental components to thrive well in the system. It can be the soil, climate, water, energy, and anything helping the sustenance of the organism. The abiotic components impact the survival of living organism.

In an ecosystem, if one factor is changed, it can impact the whole system. The availability of the other resources in the system can be impacted as a whole. Human beings are capable of altering the physical environment through development, construction, farming, and pollution. As a result the abiotic components in the system change and affect the biotic organisms. Global warming affects many organisms like plants and microbes. Acid rains have resulted in the destruction of the fish population too.

Apart from biotic and abiotic factors, there are some factors which determine the number and types of organisms in a system. These factors are known as limiting factors. The limiting factors are capable of restricting the overpopulation of any species. At the Arctic, the permanently low temperature restricts the growth of trees and other plants.

- Explain how abiotic factors affect the ability of plants to create their own food

A number of abiotic factors affect plant in different ways. Rain is an important limiting factor that effects plant growth. Scarcity of water in any ecosystem could affect plant growth. As you have studied earlier, plants are producers and for synthesis of food they require several abiotic components.

These abiotic factors are water, carbon di-oxide, mineral nutrients in the soil and solar energy.

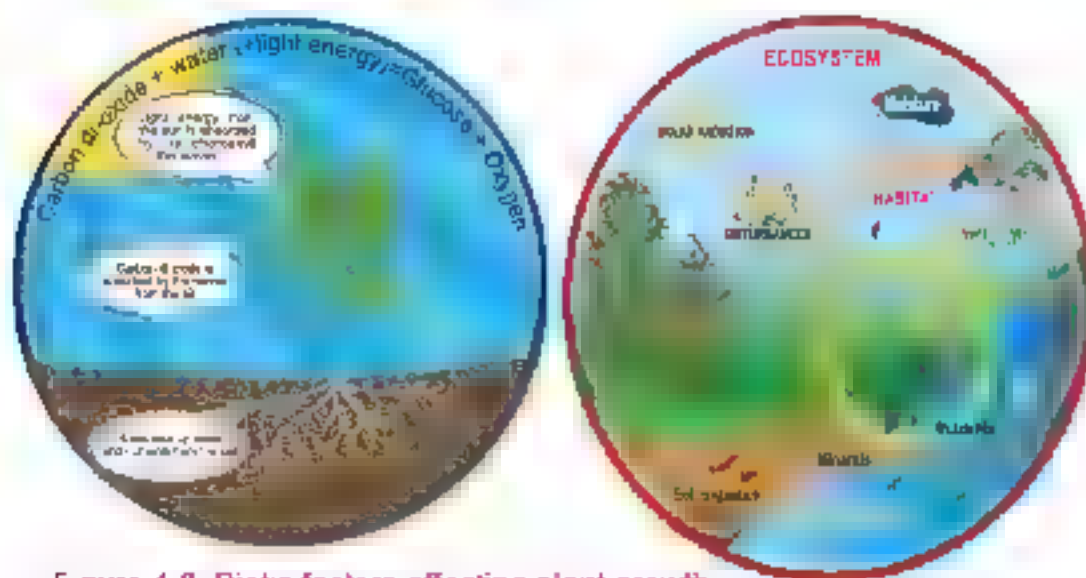



Figure 4.8: Biotic factors affecting plant growth

The scarcity of any of these components **water, carbon di-oxide, mineral nutrients in the soil and solar energy** will affect the synthesis of food by plants through the process of photosynthesis.

In the desert environment there are very few plants, since the limiting factor water is found in very low quantity. In arctic regions the growth of plants is also very controlled because of the limiting factor solar energy. Also soil nutrients could affect plant growth, suppose a farmer plants corn in soil and provide enough water, but no soil nutrient as manure. What will happen to the corn plant? In the absence of appropriate soil nutrient the corn will not grow.

RELATIONSHIPS IN ORGANISMS

✓ Explain the different relationships between organisms.

The organisms in a community with similar activities and need interact with one another. The organism may be harmed by, benefited from or remain unaffected by these interactions. The kinds of interaction between organisms are **predator-prey, parasitism and mutualism**

The Kinds of Interactions are as follows

These interactions help in regulating the population and survival of organisms in different environmental conditions

1 Predator-prey relationship.

In the **predator-prey** interaction the predator feed directly on another living organism the prey. The interaction harms the prey, but the prey may or may not die from this interaction. The picture shows a predator-prey interaction. In this predator-prey interaction the deer (prey) is clearly harmed

Figure 4.9 A lion hunting a deer

Explore predator-prey interactions in your surrounding and share with your classfellows.

2. Parasitism

Figure 4.10: A mosquito sucking blood

In parasitism the organism parasite feeds and lives in or on part of another organism, the host. In this relationship the host is harmed. Observe the parasite on the host. How is this different from the predator?

Parasite is type of a predator but unlike the predator it is smaller than the host, remains associated with the host and draws nourishment from the host and rarely kills the host. Explore parasite-host interactions in your surrounding and share with your classfellows.

3. Mutualism

Figure 4.11: A honeybee sucking nectar from flower

In mutualism two organisms interact in such ways that benefits both. For example the honeybee visits male flowers for nectar and in this process picks up and transfer pollen grains from male to female flowers when it visits female flowers. So benefiting the plant in pollination process for reproduction.

Figure 4.12: Mutualism between birds and a buffalo

Many mutualistic relationships also provide a combination of nutrition and protection. For example the birds that ride on large buffalos and elephants. The birds eat parasites from the animal body and also make noises warning the animal when predators come closer.

Do you know?

The food chain is delicate

The food chain describes the intricate combination of prey and predator that exists within the world and it lays out plants and plant-eating animals as well. Whereas a spider might eat a fly, a bird may eat the spider, and the bird in turn, may be eaten by a larger bird or a big cat. This "chain" works itself up from the smallest plant items on earth right to humans, and it can be disrupted extremely easily. Because of this, if a single animal type is wiped out, it can have additional devastating consequences on the animals or plants that rely on it in turn.

SUMMARY
Environment and interaction
Biotic Component
Ecosystem
Abiotic Component
This community of biotic and abiotic components and their interactions for survival in the environment make up an ecosystem.
The interactions between biotic and abiotic components in ecosystems help in maintaining the balance of the system.
Scarcity or abundance of abiotic factors affects the survival of the biotic components in an ecosystem
Kinds of Relationship
Predator-prey
Parasitism
Mutualism
The organisms in a community with similar activities and need interact with one another. The organism may be harmed by, benefited from or remain unaffected by these interactions

1. **The following is an example of an abiotic part of an ecosystem,**
   (a) micro-bacteria
   (b) fungus
   (c) minerals
   (d) decaying plants

2. **The following is an example of biotic component of an environment.**
   (a) bacteria on the surface of your skin
   (b) the mineral in the soil
   (c) the water in pond
   (d) the temperature of your surrounding

3. **Tapeworms that live inside organisms and feed on the nutrients of the food organism eat, are an example of**

   (a) mutualism
   (b) parasitism
   (c) predator-prey
   (d) carnivores

4. **Organisms in an eco-system can be classified as producers or consumers. The producers provide food for the consumers. Name the organism that consumes both producers and other consumers**

   (a) herbivore
   (b) omnivore
   (c) carnivore
   (d) prey

5. **Carbon is an integral part of an ecosystem. It is cycled throughout the ecosystem as it is used and then reused. It is necessary for all life to exist. Name the process in which plant uses carbon di-oxide**

   (a) respiration
   (b) photosynthesis
   (c) transpiration
   (d) decomposition

6. **Photosynthesis is a chemical reaction that occurs in the leaves of plants. But it requires a special gas abiotic component from the atmosphere. What is this substance?**

a) Carbon di-oxide
b) Chlorophyll
c) The sun's energy
d) Oxygen

Ecological footprint:

We depend on fuel components for our transportation. Each method of transportation has its impact on the environment through waste. Depending on the transportation you use you produce different quantities of waste.

Using the calculation chart below, find out your foot print for a week.

Transport	Name	Amount of waste g/km
	Walking	0
	Cycle	0
	Car	200

Day								Total
Transport used								
Amount of waste produced								

ATOMS, MOLECULES, MIXTURES AND COMPOUNDS

What different forms do substances exist in? How are metals different from non metals? What are mixtures? How could mixtures be separated?

Figure 5.1 Various chemicals

Have you ever wondered? What chemicals like these are made up of?

In this Chapter you will learn about:

- Introduction to atoms and molecules
- Some common elements and their symbols
- Classification of elements (metals and non-metals)
- Uses of some common elements
- Compounds and mixtures
- Uses of compounds and mixtures
- Air as a mixture of gasses
- Separating mixtures (filtration, sublimation, distillation and paper chromatography)

All the students will be able to

- ✓ Differentiate between an atom and a molecule
- ✓ Recognize symbols of some common elements
- ✓ Classify elements into metals and non-metals
- ✓ Relate the physical properties of elements to their use.
- ✓ Differentiate between element and compound and compound and mixtures.
- ✓ Identify examples of compounds and mixtures from the surroundings
- ✓ Explain uses of common mixtures in daily life.
- ✓ Explain why air is considered as a mixture of gases.
- ✓ Identify the sources of carbon di-oxide and how its level can be maintained in nature
- ✓ Separate mixtures using a variety of techniques.
- ✓ Choose a technique to separate and identify different components in dyes
- ✓ Demonstrate with an experiment to separate soluble solids from mixture.
- ✓ Use safety measures to conduct science experiments.

INTRODUCTION TO ATOMS AND MOLECULES

- ✓ Differentiate between an atom and a molecule.

The diagram below shows us the image of the atom. Everything you see around you, including yourself is made up of millions of atoms. From the tip of the pencil to huts, houses and plants around you, all are made of millions of atoms. Atoms also have particles inside them, are known as the **Electrons, Protons** and **Neutrons.**

An atom can be defined as "An atom is the smallest possible particle of an element which has all the properties of that element"

Elements are made up of atoms. All atoms of **an element** are similar. **Hydrogen** is the simplest element. The most common element found on earth is oxygen. Each element has its own set of properties through which it can be identified.

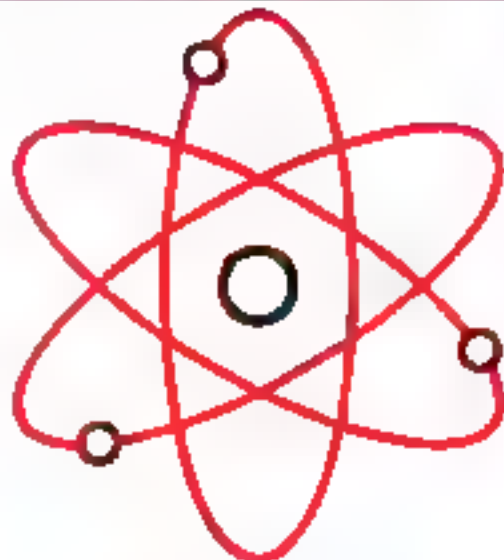



Figure 5.2: Diagram of an atom

Do you know?

Rutherford was the first person to draw an **Atom** including **Electrons** surrounding **Nucleus**

When two or more **Atoms** combine together a molecule is formed. Water(H_2O) is an example of two atoms of **Hydrogen element** forming a molecule with one atom of **Oxygen** element.

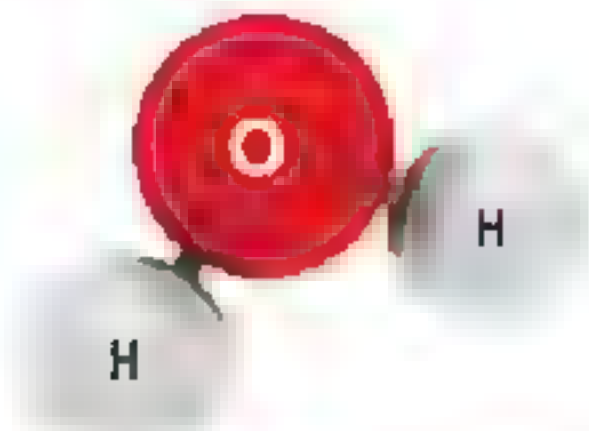



Figure 5.3: Molecular form of water (H_2O)

A molecule is defined as "**A molecule** is the smallest particle of a compound and is made up of groups of atoms." **Molecules** are not always made up of different elements. Many molecules in our atmosphere are made up of same elements. This means that when two or more atoms of the same elements combine with each other they form a molecule. In Air there are many of these molecules such as Oxygen as O_2 and Nitrogen as N_2

Figure 5.4: Molecular form of oxygen (O_2)   Figure 5.5: Molecular form of nitrogen (N_2)

COMMON ELEMENTS AND THEIR SYMBOLS

✓ Recognize symbols of some common elements.

All these different type of atoms that exist around us belong to a particular element. All **elements** are given a name and a symbol to represent them. The common elements that exist around us are as follows

Name of common element	Symbol
Hydrogen	H
Sodium	Na
Carbon	C
Nitrogen	N
Oxygen	O
Flourine	F
Chlorine	Cl
Potassium	K

Name of common element	Symbol
Helium	He
Neon	Ne
Calcium	Ca
Sulphur	S
Phosphorous	P
Aluminium	Al
Magnesium	Mg
Iron	Fe

We have studied that sub-atomic particles, electrons, protons and neutrons are in an atom. Atoms then combine to form molecules. Molecules could be formed of similar or different atoms of elements.

Elements are the simplest form of substance. There are almost 120 elements found in nature. All elements have a name and are represented by a symbol.

The elements exist in different states and have different properties. Some elements are found in gaseous, some in solids and some in liquid state. Some elements are light, some are hard, some have a shiny look and some can be made into thin sheets and wires.

Elements are used in different ways according to their respective physical properties.

USES OF SOME COMMON ELEMENTS

✓ Relate the physical properties of elements to their use

Hydrogen is lightest gas and is used for filling party and advertisement balloons.

Aluminium, Magnesium, Iron are hard used in building cars, bridges and houses.

Figure 5.6 Balloons filled hydrogen

Figure 5.7 Car and bridge made of metal elements

CLASSIFICATION OF ELEMENTS (METALS AND NON-METALS)

✓ Classify elements into metals and non-metals.

Metals and non-metals are two important groups of elements on earth. Metal are usually solid at room temperature and hard. Metals can be drawn into sheets and wires. Non-Metals are often gases but some are also solids, for example coal and sulphur. Non-metals are dull and soft. Non-metals cannot be drawn into wires or sheets. Observe your surroundings. Can you find a metal and a non-metal? What is the difference between a metal (iron nail) and a non-metal (carbon coal and sulphur)?

Figure 5.8 Coal and Sulphur

The differences between metals and non-metals are summarized below

Metals	Non-metals
• Usually solids at room temperature	• Often gases
• Mostly high melting and boiling point	• Low melting and boiling point
• Good conductors of heat and electricity.	• Poor conductors of heat and electricity
• Often shiny, ductile and malleable (can be drawn into wire and sheet) and possess great tensile strength	• Normally dull, soft, and cannot be drawn out into wires or made into flat sheets

COMPOUNDS AND MIXTURES

- ✓ Differentiate between element and compound and compound and mixtures.
- ✓ Identify examples of compounds and mixtures from the surroundings.
- ✓ Explain uses of common mixtures in daily life.
- ✓ Explain why air is considered as a mixture of gases.

Figure 5.5: Water - A commonly available compound

Compounds

Compounds are made up by chemical combination of two or more elements. They could be broken down through various chemical processes into elements. While elements cannot be broken down to more simpler forms any further. Various elements combine in different ratios to give different compounds. Water composed of hydrogen and oxygen is therefore a compound. Carbon di-oxide is composed of carbon and oxygen. Common salt is chemical combination of sodium and chlorine, while sugar is carbon, hydrogen and oxygen. Washing soda is compound of carbon and oxygen.

Compounds are represented by formula which is actually symbols of combining elements with their ratio

Water (H_2O)

Carbon di-oxide (CO_2)

Common salt, Sodium chloride ($NaCl$)

Washing soda, Sodium carbonate (Na_2CO_3)

Mixtures

A **Mixture** is a combination of substances. It is made up of two or more substances, which are not combined chemically. Most foods are mixtures. The substances in mixture can be all elements, all compounds or a mixture of elements and compounds. The substances in a mixture can be solids, liquids or gases.

A mixture possesses the properties of the substances, which make up the mixture, for example air is a mixture of many gases such as oxygen, nitrogen, carbon di-oxide and others. A salad is a mixture of different vegetables. You can change the amount of substances in a mixture.

Mixtures	Compounds
• Mixtures are made up of two or more substances that are not chemically combined, for example air	• Compounds are made up of two or more elements that are chemically combined for example water or salt
• A mixture possesses the properties of its components.	• A compound may have properties that are different from its components.
• A mixture can be separated into components by physical methods.	• A compound can be broken down into its components by chemical methods.
• Components of mixture are not mixed in fixed ratio	• Components of compound are mixed in a fixed ratio.

A Mixture we interact with every day in life is Air

Air is a mixture of gasses.

78% Nitrogen
21% Oxygen
0.9% Other Gasses
0.037% Carbon di-oxide

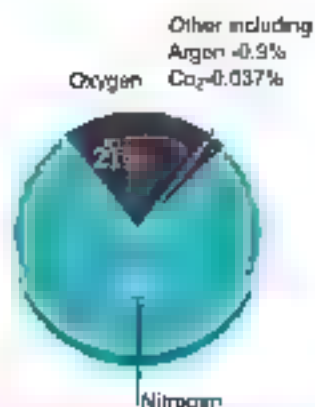



Figure 5.10: Pie-chart of gasses present in air

Uses of mixtures in our daily life and nature

- Steel is a mixture of iron and carbon and used in making pots and pans.

- 'Sharbat' is mixture of sugar,water and rose flower essence.

- The tea is also a mixture of water, tea leave extract and sugar

CARBON DI-OXIDE: ITS SOURCES, USES AND MAINTENANCE IN NATURE

- ✓ Identify the sources of carbon di-oxide and how its level can be maintained in nature

Figure 5.1 Molecular form of Carbon di-oxide

The compound produce from burning gets into our atmosphere as **Carbon di-oxide gas**. Carbon di-oxide consists of one atom of **Carbon** and two atoms of **Oxygen**. The following are the sources of carbon di-oxide in nature.

Sources of Carbon di-oxide

- Burning of fossil fuels, wood, coal
- Respiration
- Car exhaust smoke

There are however some negative impacts of Carbon di-oxide in the atmosphere. While being harmful to human's lungs Carbon di-oxide is also one of the main reason for global warming due to the **Green House** effect.

Due to these harmful effects of Carbon di-oxide its levels in the atmosphere need to be maintained. This can be done by

"Using alternative sources of energy such as Solar Power and Wind Power generators instead of burning fossil fuels."

"Planting more trees that convert carbon di-oxide to glucose in the process of photosynthesis."

SEPARATING MIXTURES (FILTRATION, SUBLIMATION, DISTILLATION AND PAPER CHROMATOGRAPHY).

- ✓ Separate mixtures using a variety of techniques
- ✓ Choose a technique to separate and identify different components in dyes.
- ✓ Demonstrate with an experiment to separate soluble solids from mixture.

The mixture can be separated into components by different means.

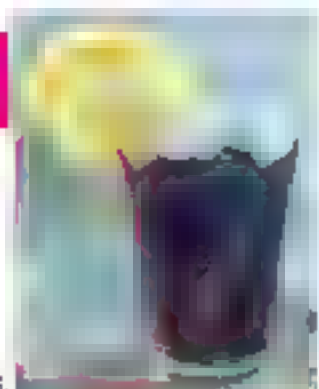



Figure 5.12 A glass of juice

You have earlier studied some methods for separating mixtures. Some common physical methods for separating mixtures are

1. Filtration
2. Crystallization
3. Distillation
4. Sublimation
5. Chromatography

1. Filtration

It is a process of separating insoluble solids from a mixture. We can separate insoluble particles from solvent by passing through a filter paper. We can get clear solvent by the process of filtration.

Figure 5.13: Filtration apparatus setup

Activity: Separating Insoluble Solids

What I need

- Sand, salt and sawdust
- Cloth piece or filter paper
- Jars 4-5
- Spoon
- Water
- Funnel

What to do

1. Work in a pair or group.
   Take some water in a beaker or a jam jar.
2. Add some sand, salt and sawdust to the water.
3. Mix it well.

Activity questions

What happened when you added water?
Which materials dissolved in water, which materials sank to the bottom, which material floated in water?
You must have observed that the salt dissolved in water. The sand sank to the bottom and the sawdust floated on the top.

What to do next:

1. Set up the Filtration apparatus as shown in the figure
2. Fold the filter paper into half, then fold it in quarters, and then open from centre to form a cone as shown in figure. Next fit in the funnel cone
3. Now, pour the mixture of soil and sawdust onto the filter paper with the help of the rod.

Figure 5.14 Folding filter paper

4. This process of separation of mixture is called **Filtration**. In this process the bigger size particles of soil and the saw dust that cannot pass through the filter paper will collect on the filter paper
5. The salt solution will pass through the filter paper and collect in the beaker.

2. Crystallization

You can separate a salt solution (a soluble solid) by another process called **crystallization**.

The process of cooling a hot saturated solution to obtain crystals is called crystallization. Crystallization is used to get back the solid substance from a solution.

- In this method, you may mix the salt or sugar and water
- Pour the solution on a pan or watch glass.
- Heat the solution slowly until all liquid evaporates.
- The salt or sugar crystals will form on the pan or watch glass.

Figure 5.15 Crystallization

3. Distillation

It is a process of purifying a liquid. When we boil a liquid such as sea water, it turns into steam and evaporates, leaving behind the solid constituents present in the sea water. We can change the steam back into water by cooling. We can get drinking water from sea water from this method. This water is called distilled water.

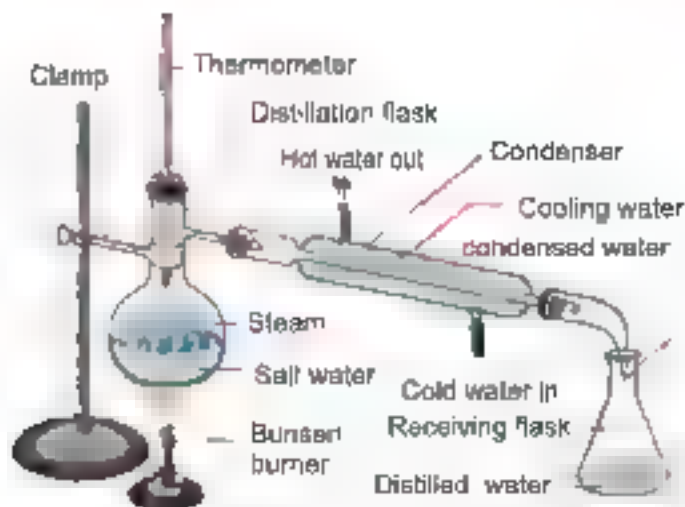



Figure 5.16: Distillation apparatus setup

4. Sublimation

It is a process of purifying a solid. When we heat a mixture with a solid sublime material as iodine, camphor or dry ice the solid directly vaporizes without passing through the liquid state. Sublimation is the process of vaporizing a solid substance and condensing the vapours to form the solid directly.

The sublimed body is recovered unchanged chemically. The process is employed as a means of purification of certain substances, which are heated in closed pans or retorts. In most cases, the temperature does not exceed a low red heat.

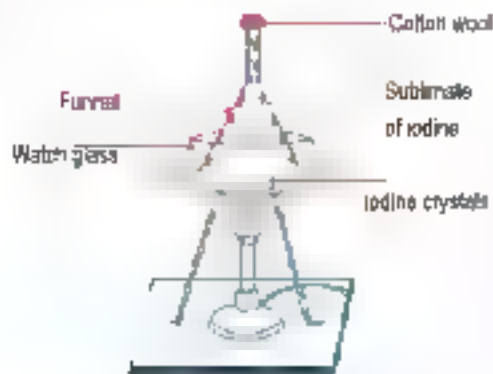



Figure 5.17: Sublimation apparatus setup

Teacher's Note: Students could be guided to work in pairs or groups. Safety measures should be shared by teachers and followed by all students.

5. Paper Chromatography

Chromatography is a method that is used to separate coloured chemicals or substances, especially dyes. Paper chromatography uses paper as the stationary phase. The exact type of material used is very important. Filter paper is one of the best types. It uses a mobile phase which is liquid in which the dye can dissolve.

Figure 5.18(a) Placing ink dots

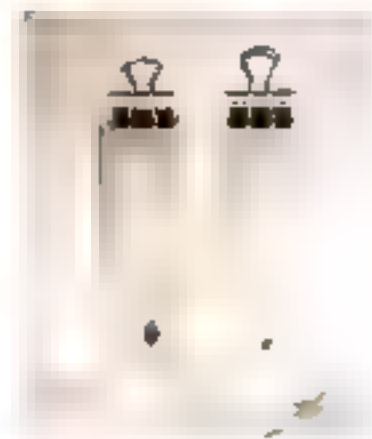



Figure 5.18(b) Chromatography set up

Figure 5.18(c) Dye separation

SUMMARY

An atom is the smallest possible particle of an element that can combine to form new compounds

A **molecule** is the smallest particle of a compound and is made up of groups of atoms.

An **element** is a substance which cannot be split into two or more simpler substances

A **compound** is a pure substance which contains only one type of molecule made up of atoms of more than one elements.

Mixtures are made up of two or more substances that are not chemically combined, for example air

Separating mixtures

Filtration: It is a process of separating insoluble solids from a mixture. We can use this method to separate insoluble solids such as sand and other particles from water by passing through a filter paper

Sublimation: It is a process of purifying a solid. Sublimation is the process of vaporizing a solid substance and condensing the vapours to form the solid directly, without passing through an intermediate liquid state

Distillation: It is a process of purifying a liquid. When we boil a liquid such as sea water, it turns into steam and evaporate, leaving behind the solid constituents in the container. We can change the steam back into water by cooling.

Paper Chromatography: It is a method that is used to separate coloured chemicals or substances, especially dyes. Paper chromatography uses paper as the stationary phase. And a liquid in which the dye dissolves as a mobile phase

Crystallization: The process of cooling a hot saturated solution to obtain crystals is called crystallization. Crystallization is used to get back the solid substance from a solution.

1. **Which of the following has a positive charge?**

   a. Proton b. Neutron c. Electron d. Atom

2. **The chemical symbol for manganese is**

   a. Mn (b. Mo c. Na d. Mg

3. **State the symbol and names of the following elements in the table below**

Na , Al , C , Cl , O , H , Ne , F , Ca , N

Symbol	Name

4. **Give two key differences between the following**

Metal	Non-Metal
1	1
2	2
Mixture	**Compound**
1	1
2	2
Atom	**Molecule**
1	1
2	2

5. **Identify and explain the process you will use to separate the following mixtures,**

   a. Sugar and water solution. b. Iron pieces and water

AIR

Have you ever thought what will happen to life on earth if there is no air around us? What is the importance of air? What are the different uses of air?

- Air and its importance
- Composition of air
- Properties and uses of gases in air

You should be able to:

- ✔ Recognize the importance of air
- ✔ Identify the composition of air
- ✔ Relate the properties and uses of gases in air with the composition of air

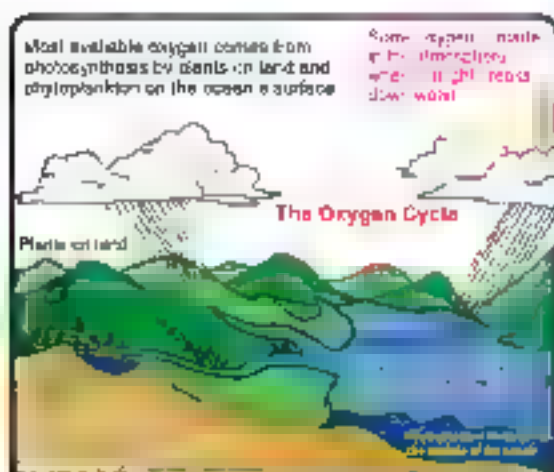



Figure 6.1 Oxygen cycle

Have you ever wondered how oxygen is made available to all living things on earth?

What's in the air?

1% other gases, e.g argon and carbon di-oxide

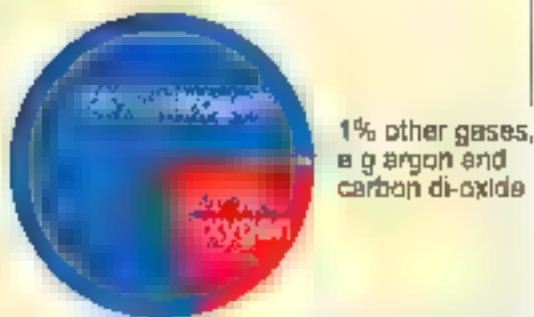



Figure 6.2 Composition of air

AIR AND ITS IMPORTANCE

✓ Recognize the importance of air

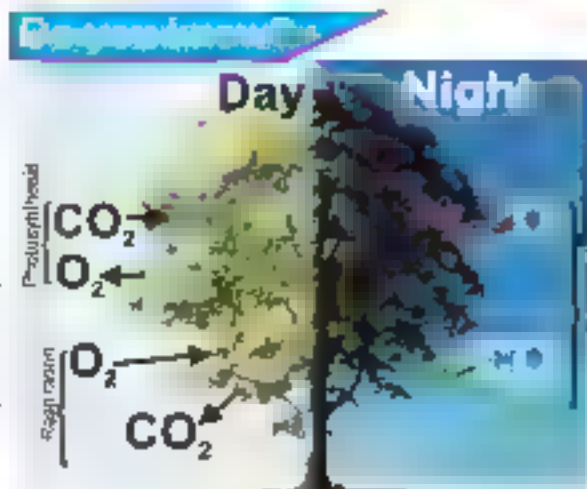
Air is needed by almost all living things. Air is essential for life and needs to be protected from getting polluted. Most plants and animals take in air which is rich in oxygen and give out air rich in carbon dioxide, in the process of respiration.

As we have studied earlier plants require both carbon-dioxide (CO_2) and oxygen (O_2). During day time plant require CO_2 for the process of photosynthesis and oxygen (O_2) for the process of respiration. While animals including human beings require only oxygen (O_2) for the process of respiration.

Another important gas present in air is Nitrogen. Nitrogen is the basic element of the plant and animal proteins. Protein is important for the growth of both plants and animals. Plants obtain nitrogen by absorbing nitrogen compounds present in the soil through the roots. And animals obtain nitrogen from plants and other animals.

A layer of ozone gas is also in air, present high up in the atmosphere, protects us from the harmful ultraviolet rays of the Sun. Also during daytime the atmosphere prevents us from excessive heat of the sun from reaching us. At night, the atmosphere traps the surface heat and prevents it from escaping.

Moving air, called wind, has great force. It enables the movement of sailboats and gliders. It runs windmills, which are used to generate electricity. And wind also helps in the dispersal of seeds.

Air is used in a number of ways. It is used to fill tyres. Many machines make use of compressed air. For example, machines used in mining and digging and the drill used by dentists, all work on compression of air.

COMPOSITION OF AIR

> ✓ Identify the composition of air

Air is a mixture of different gases that covers the Earth in a layer over 480 kilometers high. This layer is called atmosphere. Earlier we have studied the composition of air. Observe and find out the composition of the different gases in air.

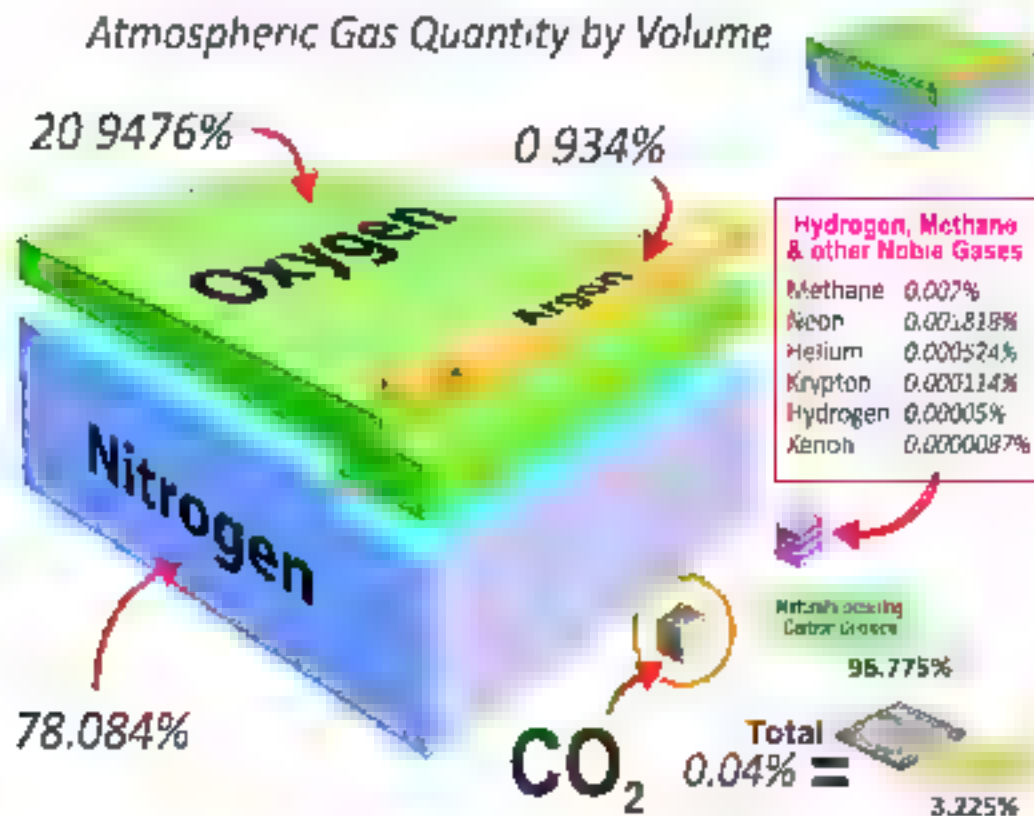



Figure 5.3. Atmospheric gas quantity

PROPERTIES AND USES OF GASES IN AIR

✓Relate the properties and uses of gases in air with the composition of air

Air is a mixture of gases but the composition of the gases in air remains approximately constant. This is because the gases used up by living things are replaced through various living processes.

Oxygen makes up approximately 21% of air. It is needed by almost all living things for respiration. It is constantly replaced during photosynthesis by plants. As studied earlier, respiration is the process by which living things produce energy from the food. **Oxygen** is necessary for this process.

Sugar + Oxygen Carbon di-oxide + Water + Energy

Do you know?

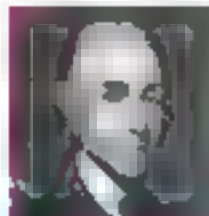
Joseph Priestley is traditionally credited with discovering oxygen in 1774.

Oxygen is also required for **combustion**, or the process of **burning**. During the process of burning fuel, oxygen and heat are required. In the process of the burning of the candle, wax is the fuel that reacts with oxygen in the air to produce carbon di-oxide, water and energy.

Figure 8.4: A burning candle

Wax + Oxygen → Carbon di-oxide + Water + Energy

Another important constituent of air is **nitrogen** that makes up **78%** of the air. **Nitrogen** is an inactive gas if compared to oxygen. Earlier it was called azote meaning 'without life'.

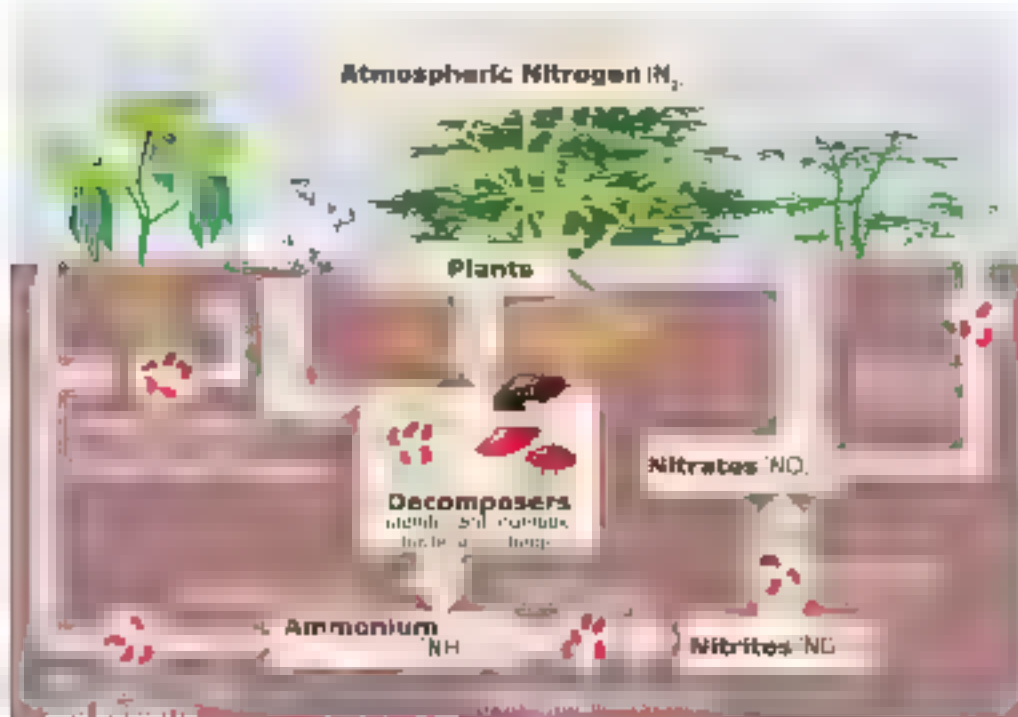



Figure 6.5: Nitrogen cycle

The process by which Nitrogen gas in the atmosphere is converted into plant and animal protein and maintained in the atmosphere is shown in the **nitrogen cycle.**

Figure 6.6: Nitrogen is used in fertilizers

Do you know?

The swellings on the roots of the leguminous plants, such as peas and beans take in nitrogen from air and convert it to nitrates. This is called nitrogen fixing.

Plants play the important role of converting nitrogen compounds such as nitrates into plant protein. Animals cannot convert the atmospheric nitrogen or nitrates to protein directly. The animals depend on plant for their protein source.

New farming techniques and production of fertilizers by chemists are employed to produce the plants for proteins needed by the fast growing human population.

Carbon di-oxide in air is in very small proportion around 0.04 %. Carbon di-oxide gets into the atmosphere through many sources but one key source is from the burning of fuels. Carbon di-oxide is required by plants for the production of glucose. Carbon di-oxide is a green house gas that traps heat radiated back from the earth to maintains the earth temperature. Excessive carbon di-oxide causes global warming.

- Air is essential for life and needs to be protected from getting polluted.
- The Earth's atmosphere is composed of a mixture of different gases.
- Air is a mixture of different gases that covers the Earth in a layer over 480 km high
- Earth's atmosphere contains 78% nitrogen, 21% oxygen, and 1% other gases. Carbon di-oxide accounts for just 0.03 - 0.04%. Water vapour from 0 -2%.
- Plants and Animals require oxygen for respiration
- Plants absorb carbon di-oxide from air to make food during the process of photosynthesis.
- Plants also form protein from nitrates produced by conversion of nitrogen in air
- Oxygen is required for combustion, or the process of burning
- Carbon di-oxide is a green house gas and traps heat radiated back from the earth to the sun thus maintains the earth temperature
- There are oxygen and nitrogen cycles to maintain the amount of the two major gases in air

1. Air is made up of many gases. Which gas is found in the greatest amount?

(a) Nitrogen
(b) Oxygen
(c) Carbon di-oxide
(d) Hydrogen

2. What is the % of oxygen in air?

(a) 90 %
(b) 50 %
(c) 21 %
(d) 1 %

3. Excessive heat from Sun is prevented by

(a) Nitrogen
(b) Oxygen
(c) Ozone
(d) Carbon di-oxide

4. **What happens when oil is burnt?**

(a) Carbon di-oxide and energy will be released
(b) Carbon di-oxide and energy will be absorbed
(c) Carbon di-oxide and energy will be neither be absorbed nor released
(d) Carbon di-oxide and energy will be sometimes absorbed and sometime released

5. **Give two key uses of the following gases in air**

Oxygen	
Carbon di-oxide	
Nitrogen	

SOLUTIONS AND SUSPENSIONS

Have you ever wondered what is formed when red 'sherbet' is added to water? Why does the sugar disappear in water? Why can you add more sugar to hot water than cold water?

- Solution and its components (solute and solvent)
- Aqueous solution
- Water as a universal solvent
- Particle model of solution
- Dilute and concentrated solutions
- Saturated and unsaturated solutions
- Solubility and effect of temperature on solubility
- Solutions and suspensions and their uses

All the students will be able to

- ✓ Differentiate between solute, solvent and solution.
- ✓ Identify solute and solvent in a solution.
- ✓ Demonstrate the use of water as a universal solvent.
- ✓ Explain the formation of solution by the particle model.
- ✓ Distinguish between, aqueous, dilute and concentrated solutions.
- ✓ Prepare saturated and unsaturated solution.
- ✓ Define solubility.
- ✓ Investigate the effect of temperature on solubility using a variety of components.
- ✓ Differentiate between solutions and suspensions.
- ✓ Identify the uses of solutions and suspensions in daily life.

Figure 7.1 Red 'sherbet' is added to water

Have you ever wondered how 'Sherbet' like these are made?

Where is the coffee and sugar in the hot coffee?

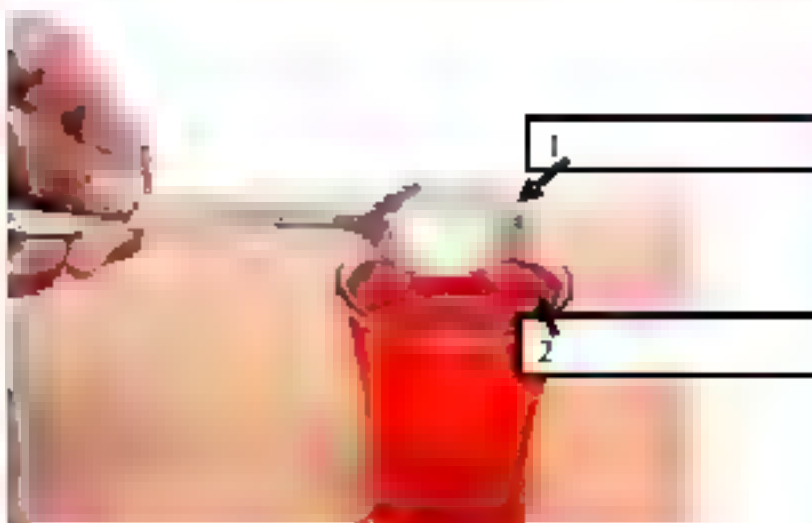
SOLUTION AND ITS COMPONENTS (SOLUTE AND SOLVENT)

- ✓ Differentiate between solute, solvent and solution.
- ✓ Identify solute and solvent in a solution

Solution is a mixture in which two components (solute + solvent) of the solution are spread evenly throughout the solution, making a clear solution.

A solution may be coloured or colourless but is always transparent.

Activity 1 Can you label the two components in solution?

A solution has two components solute and solvent

> **Do you know?**
>
> Pure water is an odourless, colourless and clear liquid. It is called universal solvent.
>
>

Solute

It is the component of the solution that gets dissolved

In the above solution sugar is solute

Solvent

Solvent is the component of the solution that dissolves the solute. In the above solution water is the solvent

AQUEOUS SOLUTIONS AND WATER AS A UNIVERSAL SOLVENT

- ✓ Demonstrate the use of water as a universal solvent
- ✓ Identify solute and solvent in a solution.

Activity 2: In the pictures given below identify the solutes and solvents in the different types of aqueous solutions. Tick the correct answer in the box

Figure7.2: Types of aqueous solutions

What is the solvent in all of the above solutions? As all the solutions in the above use water as the solvent, therefore they are called aqueous solutions

Teacher Note: Teacher will explain the formation of carbonated water

PARTICLE MODEL OF SOLUTIONS

- ✓ Explain the formation of solution by the particle model.
- ✓ Identify solute and solvent in a solution

We have studied earlier that all matter is made up of very tiny particles and these particles are in constant motion.

What happens when a solute dissolves in a solvent to form solution?

> **Do you know?**
> In a solution the components always retain their properties. These components can be separated by physical methods

Observe the picture below

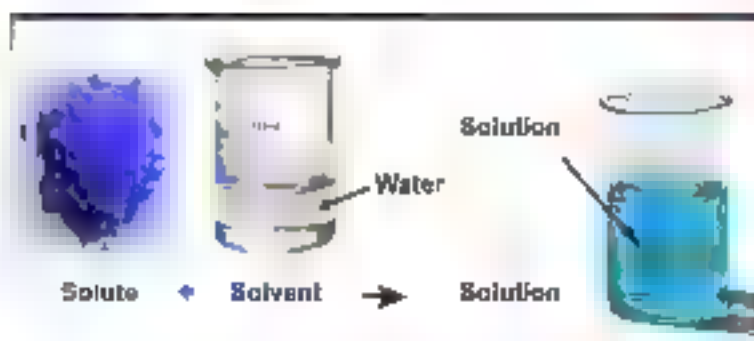



Figure 7.3 Particles of solute, solvent and solution

When a solute such as salt is added to the solvent such as water, the particles of both the solute and solvent evenly mix with each other to form a solution. In this mixture the particles of one substance (the solute) are distributed uniformly throughout another substance (the solvent), so that the mixture remains homogeneous. The resulting solution is usually clear and transparent

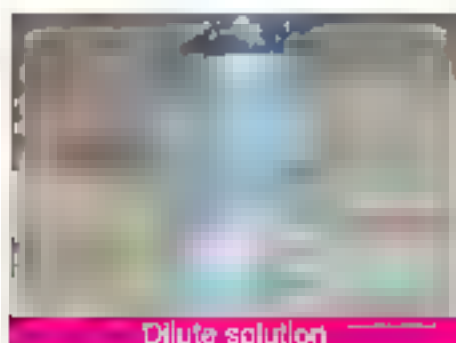
DILUTE AND CONCENTRATED SOLUTIONS

- ✓ Distinguish between dilute and concentrated solutions.
- ✓ Identify solute and solvent in a solution.

The concentration of a solution describes the relative amount of solute and solvent present in it. If the ratio of solute to solvent is high, the solution is said to

be concentrated. We can make a concentrated solution by dissolving larger quantity of solute in small amount of solvent. If the ratio of solute to solvent is low, the solution is said to be dilute.

Dilute solution

Concentrated solution

Activity 3 Pour equal amount of water in two glasses A and B. Add 1 teaspoonful of salt in glass A and 4 teaspoonful of salt in glass B and stir both the solutions.

Taste both the solutions.

- Do you require definite quantity of salt for preparing the salt water solution? Yes No
- Are the solutions of both glasses equally salty? Yes No
- Does salt retain its properties after getting dissolved in water? Yes No
- Can the salt be separated from the Water? Yes No
- Which of the two solutions is more concentrated? Why? ____

[illegible]

- ✓ Prepare saturated and unsaturated solution.
- ✓ identify solute and solvent in a solution.

Activity 4. Pour water in a glass

- Add one teaspoonful of salt in glass and stir till it dissolves.
- Add another teaspoon of salt and stir till it dissolves
- Continue the addition of salt in the water and stirring to dissolve till a point, when no further solute is dissolved in the water

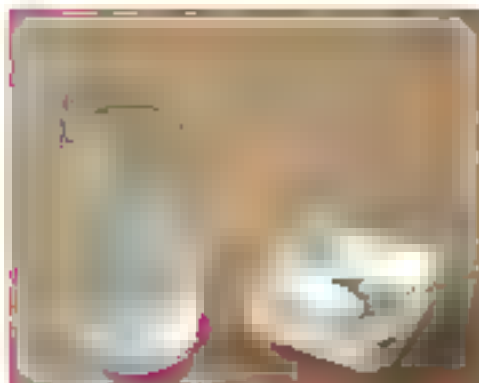



Figure 7.4(a): Un-saturated solution

Figure 7.4(b): Saturated solution

A solution that cannot dissolve any more solute in it, at a given temperature is called **saturated solution**. A solution that can dissolve solute at a given temperature is called **un-saturated**.

SOLUBILITY AND EFFECT OF TEMPERATURE ON SOLUBILITY

- ✓ Define solubility.
- ✓ Investigate the effect of temperature on solubility using a variety of components.

Solubility is the maximum quantity of the solute which can be dissolved in 100 grams of water at a given temperature. Different solutes have different solubilities at a given temperature.

The solubility of solute will depend on two factors

(i) The solute (ii) The temperature of the solvent

Activity 5: Solubility of different Solutes

1. Develop a plan with your class fellows observe the solubility of different solutes.
2. Share the plan with your teacher
3. Finalize the plan and steps of your inquiry and precautions here

4. Perform the inquiry and note your observations here

5. Note your findings and conclusion

The change in temperature also affects the solubility of solute in solvent. Most solutes are easily soluble in hot than cold water. It is our common observation that more sugar dissolves in hot water than in cold water.

Activity 6 Solubility of a substance increases with the increase in temperature

1. Develop a plan with your class fellows to prove that solubility increases with temperature.
2. Share the plan with your teacher.
3. Finalize the plan and steps of your inquiry and precautions here.

4. Perform the inquiry and note your observations here.

5. Note your conclusion:

SOLUTIONS AND SUSPENSIONS AND THEIR USES

- ✓ Differentiate between solutions and suspensions
- ✓ Identify the uses of solutions and suspensions in daily life.

Suspensions are mixtures in which the solute particles are large and remain suspended in the solvent. These particles are temporarily suspended or hanging in the solvent. Muddy water is an example of a suspension.

An insoluble substance may form a suspension

Figure 7.5: Insoluble substance suspension

The fog in winter is caused due to suspended water, smoke and dust particles in the air.

Figure 7.6: Suspensions

Activity 7 Make a list of different suspensions and solutions found in your home?

Solutions	Suspensions

Differences between solutions and suspensions

Solution	Suspension
1. The solution is a homogeneous mixture. In a homogeneous mixture the components are not distinctly visible	1. The suspension is heterogeneous mixture. A heterogeneous mixture contains two or more pure substances which are distinctly visible.
2. In a solution the particles of solute and solvent are mixed thoroughly to form a clear and transparent solution	2. In a suspension the particles of solute are dispersed in the solvent and remain suspended to form a translucent solution.
3. The colour and appearance are same in every part of the solution.	3. The colour and appearance are not same in every part of the suspension
4. The solution is clear and transparent.	4. The suspension is translucent or opaque.

✓ identify the uses of solutions and suspensions in daily life.

1. Plants and trees get nutrients from soil in the form of solution
2. Greasy substances are removed from clothes, dishes materials by solution of detergents.
3. Dye solutions are used for dyeing of clothes.
4. Soft drinks are prepared in the form of solutions.
5. When solid medicine cannot be administered orally suspension is used
6. Paints are example of suspension.

- **Solution** is a mixture in which two components of the solution are spread evenly throughout the solution.
- **Solute** is the component of the solution that gets dissolved
- **Solvent** is the component of the solution that dissolves the solute
- The solution that does not dissolve any more solute at a given temperature is said to be **saturated solution**.
- If the **ratio of solute** to solvent is high the solution is said to be **concentrated**.
- If the **ratio of solute** to solvent is low, the solution is said to be **dilute**.
- A solution that can dissolve more solute at a given temperature is called **un-saturated.**
- **Suspensions** are mixtures in which the **solute particles** are **dispersed**. These particles are temporarily suspended or hanging in the solvent
- **Solubility** is the **maximum quantity** of the **solute** which can be dissolved in **100 grams** of water at a given **temperature**. Different solutes have different solubilities at a given temperature

Review Questions

Q1 When a substance is dissolved in a liquid and no new substance is formed. What will these substances are called?

(a) Solute

(b) Solution

(c) Compound

Q2 What is the name of the substance which gets dissolved?

(a) Solvent

(b) Solution

(c) Solute

Q3. What is the name of the substance that dissolves the substance?

(a) Solvent

(b) Solution

(c) Solute

Q4. An example of a solution.

(a) Cement and water

(b) Sugar and water

(c) Sand and Water

Q5. What is one property of suspension that makes it different from solution?

(a) Suspensions are colourless

(b) Suspensions are clear

(c) Suspensions have suspended particles.

Q6. A solution that cannot dissolve any more solute at given temperature is called?

a) A weak solution

(b) A saturated solution

c) A concentrated solution

Q7 The solubily of a solute substance increases.

(a) As the liquid cools down

(b) As the liquid heats up

c) As the liquid remains at room temperature

Q8. Give brief answers

Provide one difference and one example of each.

i) Solution and suspension.

ii) Saturated and un-saturated Solution

iii) Concentrated and dilute Solution

Q9. Explain the formation of solution with the help of particle model.

8 ENERGY AND ITS FORMS

Have you ever wondered when you wake up and have breakfast in the morning, why you are at your most active? It's because you have had food and are fresh, you have a lot of energy to perform tasks. Tasks like going to school and studying, playing games with your friends and doing household chores at home with your family. And at the end of the day, when you are tired and don't have energy to do anything, you go to sleep. It's because you are all out of energy.

ENERGY

- ✓ Explain that energy provides the ability to do work and can exist in different forms.

Energy is the ability which enables us to perform various tasks and activities, basically to do work.

Energy is the ability to do work. It helps us to work throughout the day. It is measured in joules (J). Energy is not just inside ourselves. It exists all around us, in various different forms.

Figure 8.1: A man lifting weight

The heat and light we get from the sun, the strong currents of wind, the fuel we put in our cars, the electricity we get in our homes, all these are different forms of energy that exist in our surrounding. Can you name some more examples?

In this Chapter you will learn about:

- Energy
- Forms of energy (potential, kinetic, heat, electrical, light and sound)
- Conversion of different forms of energy
- Conservation of energy
- Energy converters (radio, TV, Lamp, washing machine, calculator, drill)
- Renewable energy sources
- Energy in our lives

All the students will be able to

- ✓ Explain that energy provides the ability to do work and can exist in different forms
- ✓ Identify different forms of energy with examples
- ✓ Differentiate between kinetic and potential energy
- ✓ Demonstrate how one form of energy is converted into other form of energy.
- ✓ Identify that energy is dissipated in atmosphere
- ✓ Explain that energy is conserved during conversion of different forms of energy
- ✓ Explain the importance of energy in improving the quality of life
- ✓ Identify energy converters in their surrounding.
- ✓ Illustrate energy conversion to other forms using an energy converter
- ✓ Explain the term renewable
- ✓ Describe the advantages of using renewable energy sources
- ✓ Describe the form of energy stored in the human body
- ✓ Identify energy transfer in an environment.

- ✓ Identify different forms of energy with examples
- ✓ Differentiate between kinetic and potential energy

Activity 1 Observe your surrounding and make a list of forms on energy.

There are also other forms of energy those which are not so evident in the environment, but are still there. Like the energy which every moving object (a car, a runner, a bicycle) has, kinetic energy. Or the energy you gain when you are at a height from the ground is called potential energy.

Figure 8.2(a): A runner

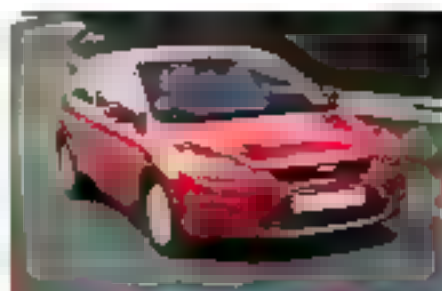



Figure 8.2(b): A car

Forms of energy

Energy exists in various different forms, in our surroundings. The following are some types of energy, with examples.

Figure 8.3: The sun

Thermal energy: Is the energy we get from heat. Heat makes everything on which it is applied, warm. When we boil water we are heating it, which makes it boil. Another natural form of thermal energy is the Sun. The Sun provides all of our solar system with thermal energy and warmth.

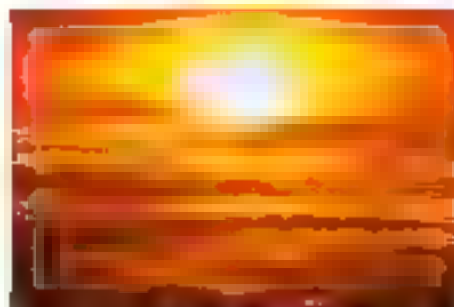
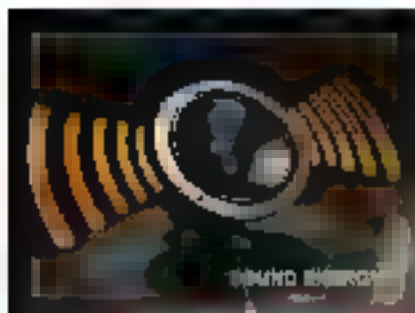



Figure 8.4: A speaker

Sound energy: Is the energy which is created by vibration of particles. Sound dissipates each

travels from particle to particle by creating vibrations in them. The louder the sound the more energy it has, hence it causes a greater vibration in particles. However sound cannot travel in vacuum, which means sound always needs a medium (air particles, solid particles) to travel. Some examples of sound energy are the sound from a radio, a TV or a car engine.

Electrical energy: Is also another form of energy which is the flow of negatively charged electrons in an electrical circuit. Electricity is a very essential part of our lives. It is essential to run all the appliances in our homes, like lights, fans and TV.

Kinetic energy: Is the energy which every moving object possesses.

It is the energy which comes from motion, the greater the motion, the greater the kinetic energy. A car driving at a fast speed, a man riding a bicycle, electrons moving in an electrical circuit or even a child running, all these are examples of kinetic energy because the object is in motion.

Figure 6.5(a): Kinetic energy

Potential energy: It is basically the stored energy that every object has. If an object is not in motion, but is completely stationary, it has potential energy. Potential energy is the measure to determine how much energy an object has and in turn how much work can it perform.

Figure 6.5(b): Potential energy

Potential energy is also affected by height or position, the higher an object is, the greater amount of potential energy it has. For example a stone lying at a height or a book placed on a table or a pressed spring possesses potential energy.

All forms of Energy can be classified as Kinetic and Potential Energy.

✓ Differentiate between kinetic and potential energy.

The difference between Kinetic and Potential energy are as follows

Kinetic energy	Potential energy
• It is the energy which comes from motion • It is dependent upon the mass of the object and the speed at which it travels	• It is the stored form of energy in every object • It is dependent upon the mass of the object and the height of the object above ground

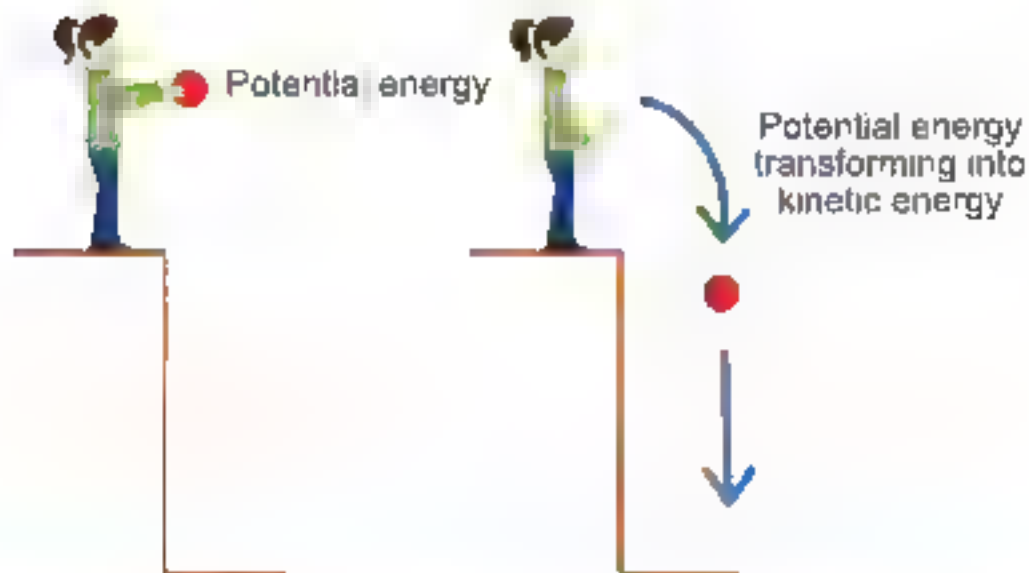



Figure 8.6: Conversion of potential energy to kinetic energy

CONVERSION OF DIFFERENT FORMS OF ENERGY

✓ Demonstrate how one form of energy is converted into other form of energy.

Energy exists in different forms on Earth. But it doesn't always stay in one form. It changes from one form to another, depending upon the situation. For example, a TV requires electrical energy, which it converts in the form of light and sound energy. Another example of electrical energy conversion into light and heat energy is an electric bulb.

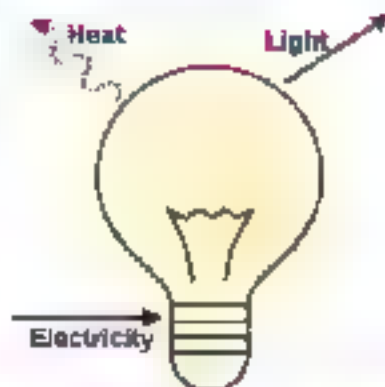



Figure 8.7(a): A light bulb

The fuel is another form of chemical energy which the car uses. It is converted into kinetic energy in the through engine.

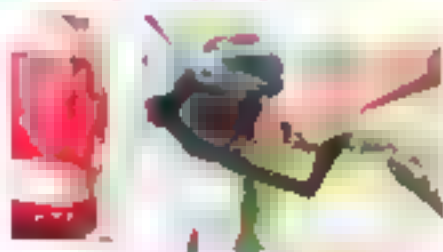



Figure 8.7(b): Fuel

TRANSFER OF ENERGY TO THE ENVIRONMENT

✓ Identify energy transfer in an environment

When the TV is supplied with electrical energy, it converts some portion of that energy to give us images in the form of light, it gives us sound and the rest of the electrical energy is given off into the environment as heat.

When a bulb is supplied with electrical energy, not all of it is converted to give us light, some of the energy is spread into the environment as heat. That's why the bulb is very hot when it is lit.

Activity 2: Can you name some more examples of the transfer of energy into the environment?

____

____

CONSERVATION OF ENERGY

- ✓ Identify energy converters in their surroundings
- ✓ Explain the importance of energy in improving the quality of life

There is a law in physics, the law of conservation of energy. Which says that energy can neither be created, nor be destroyed but it can be changed into different forms. Whenever energy is transferred, it is converted from one form, to another forms of itself. This way energy is always conserved, never lost.

This law can also be observed in our surroundings, when chemical energy from fuel in a motorcycle is converted into kinetic energy making it move. However some of the energy is converted to heat and sound as well and released to the surrounding.

Whenever we use a washing machine to wash clothes, it converts electrical energy to give us kinetic energy (used in rotor, to wash clothes) but sound and heat are also released into the surrounding. This way the unused energy is not lost, but conserved. In both examples the total input energy supplied, remains the same as the total output energy.

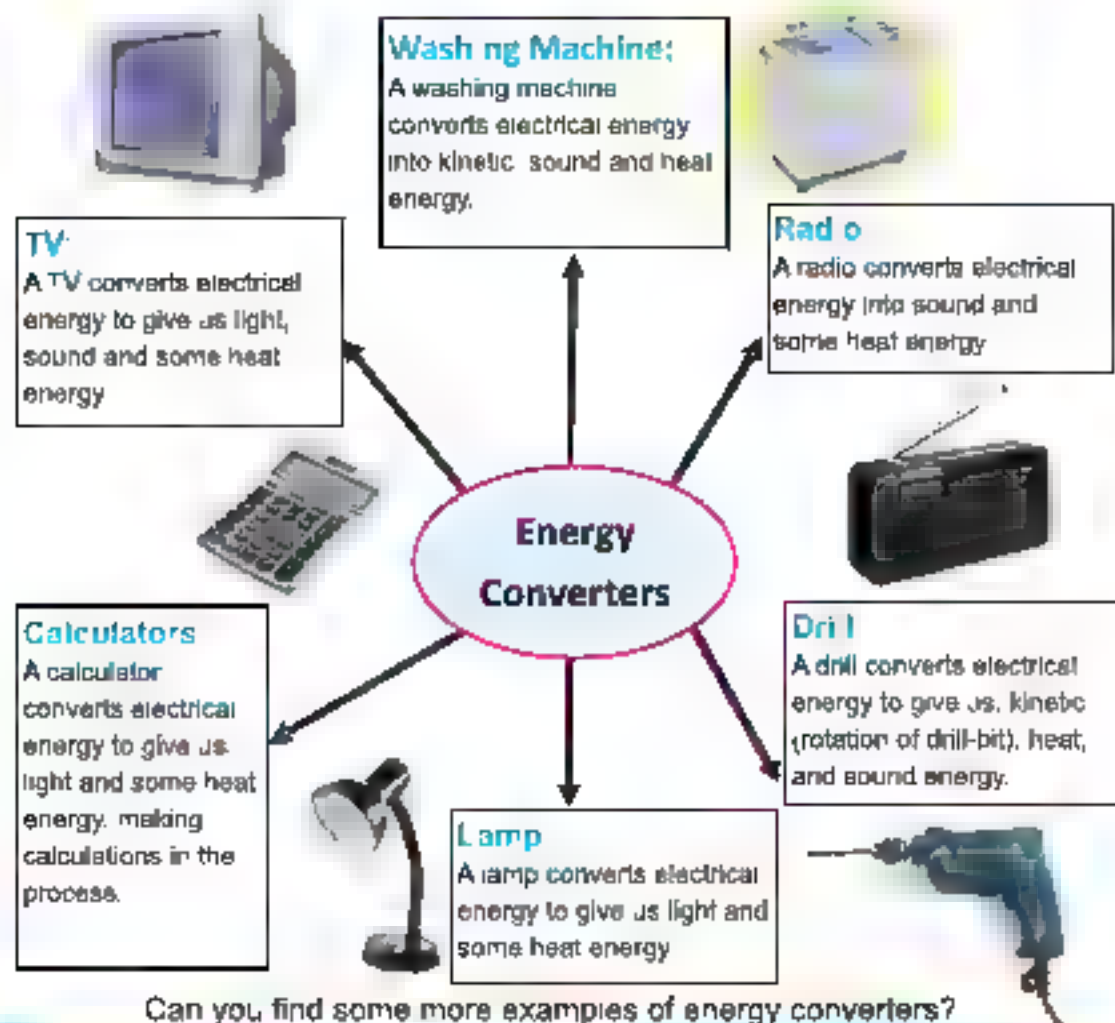
ENERGY CONVERTERS

- ✓ Illustrate energy conversion to other forms using an energy converter.

The machines and appliances which convert one form of energy to another, in order to conserve it, are called **energy converters**. Energy converters also help us to achieve more work, they improve our quality of living.

The more energy converters (i.e TV Washing machine, Lamp, we have at our disposa the more work we are able accomplish. Thus helping us to utilizing energy more efficiently and improve our standard of life

An energy converter is a machine which converts one form of energy to another They can be common household appliances which helping us to utilize energy in a more efficient manner The following are some common energy converters we have in our surroundings

Can you find some more examples of energy converters?

RENEWABLE ENERGY SOURCE

- ✓ Explain the term renewable
- ✓ Describe the advantages of using renewable energy sources.

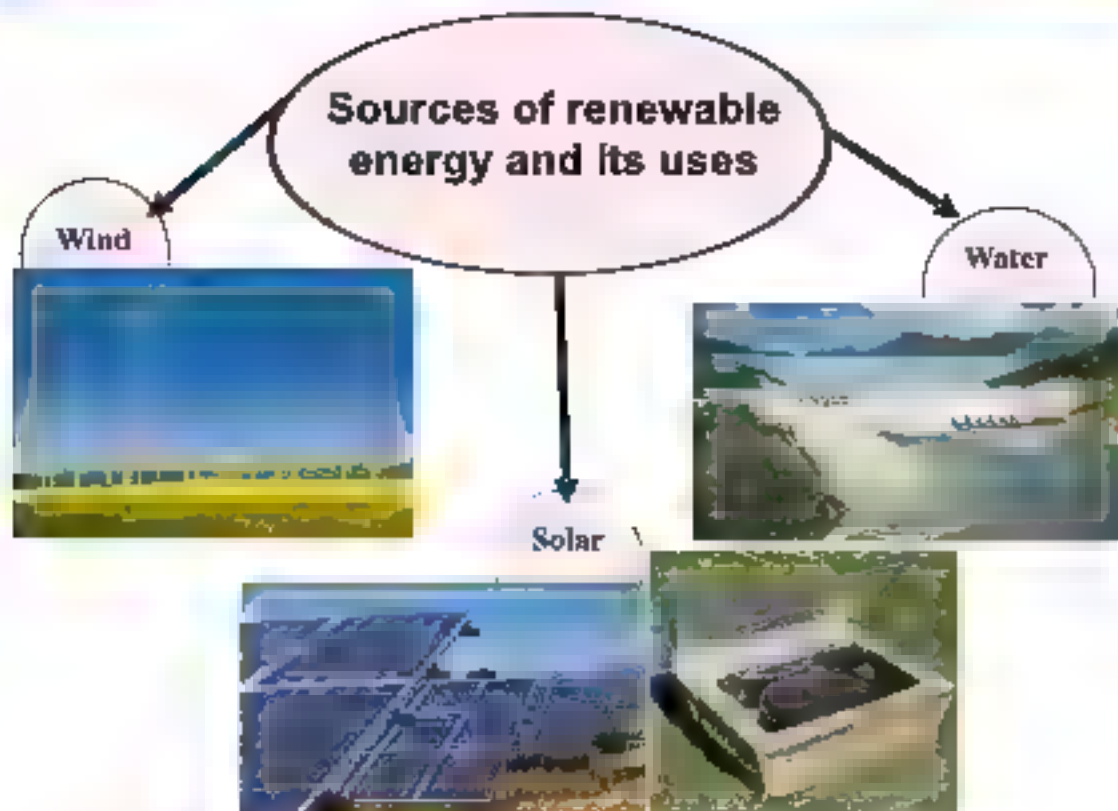
Now that we have established that every machine requires energy to function, let us examine where all this energy comes from. Majority of the world is powered by fossil fuels. Fossil fuels are the product of decaying organic matter from hundreds and millions of years ago, present in the Earth's crust. Fossil fuels can be found in the form of crude oil, gas

Coal

Crude oil

and coal which is used to power most of the world. Now there are many benefits of using fossil fuels as the primary source of energy, but there is one disadvantage which overrides all the advantages. That is, fossil fuels are a **non-renewable** form of energy. They are limited, they can't be used over and over again. And one day we are bound to run out of fossil fuels, what will we do then? Can you think of a world without energy?

Luckily we have other sources to harness energy, those which are unlimited in magnitude. These limitless sources of energy are also called **renewable sources of energy**. These renewable energy sources include primarily the sun, wind and water. These resources can be used over and over again, hence making them unlimited.

Gas

Project: Making a solar powered cooker

What do you need

The following are the materials you need to make a solar powered cooker

- a cardboard box
- a cutter
- a few sheets of aluminium foil
- some black paint
- Glue and scissors

What to do:

The following steps should be performed with care, and help of your teacher should be taken when using the cutter

- Firstly, use a cutter to cut out a large square from one side of the cardboard box
- Paint the box as black from the outside
- Use glue to stick aluminium foil sheets on the inside of the box, don't leave any space uncovered
- Finally put a metallic beaker in full of water and put your solar cooker in sunlight. (Make sure that the top of the box is open and plenty of sunlight is given to the cooker).
- After a few hours in sunlight, the water will become very hot

Although a solar cooker may not be very efficient, but it is powered by sunlight, which is present in the environment as an unlimited source of energy and can be used repeatedly.

Figure 8.8. A solar powered cooker

Teacher Note: Engage and help the students in performing this activity. Should also stress upon the importance of using renewable energy, and help students in realizing its benefits

Other advantages of using renewable energy over fossil fuels include various environmental benefits, as it produces no waste or toxic products to pollute the environment. And it would be more cost efficient as it is of unlimited supply and can be easily harnessed.

If we are to sustain the environment of Earth, we must start using renewable energy for all our basic needs, because the pollution of air, land and sea caused by fossil fuels is very dangerous for future life.

Energy in our lives

Now as we have studied throughout the chapter that energy is all around us, existing in its various different forms. It is never lost, it is only conserved, by being converted from one form to another.

Figure 9.9: Energy lost in transmission

And we have also studied how electrical energy is converted into other forms by machines which make life easier for us. But this is just inside of our homes, but what happens with the energy in our environment? How is it conserved?

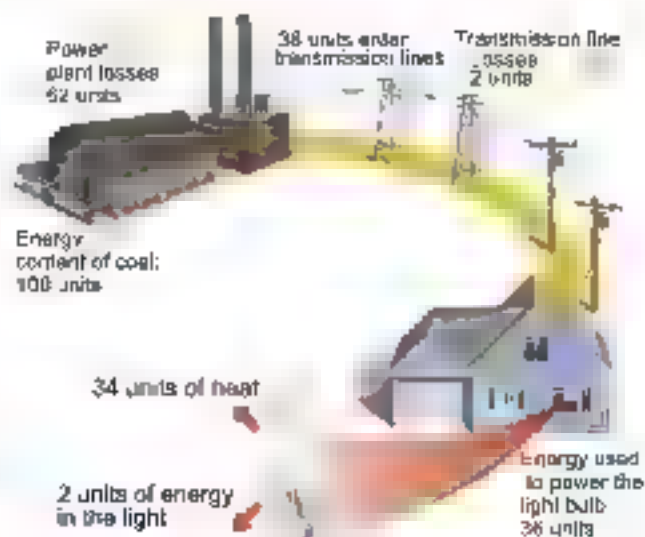
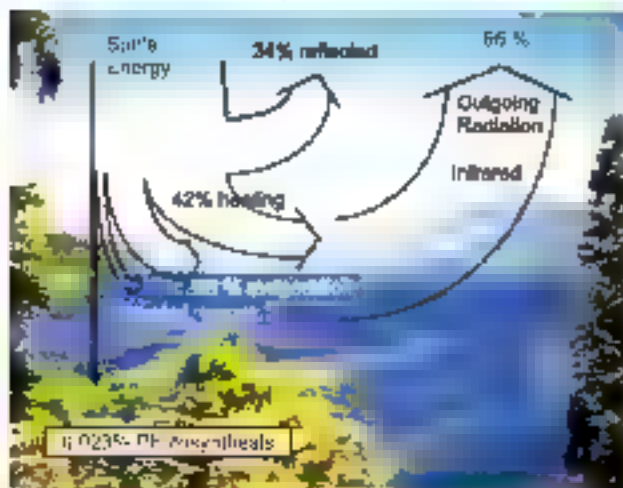



Figure 9.10: Sun's energy lost in transmission

Energy in the environment, like all other forms of energy, is never lost. It is merely converted to other forms of energy, which dissipate into the environment.

Like for instance, if it is a very hot day all the energy which the sun gives us is converted to heat energy which then affects our environment, making it warmer. This heat energy also causes the water in the ocean to evaporate making the atmosphere humid as well. The plants also use this energy from to the sun and convert the light energy to chemical energy.

Another example of energy conversion in the environment is the collective heat energy produced by all the automobiles making the temperature of the atmosphere rise.

ENERGY STORED IN THE HUMAN BODY

- ✓ Describe the form of energy stored in the human body

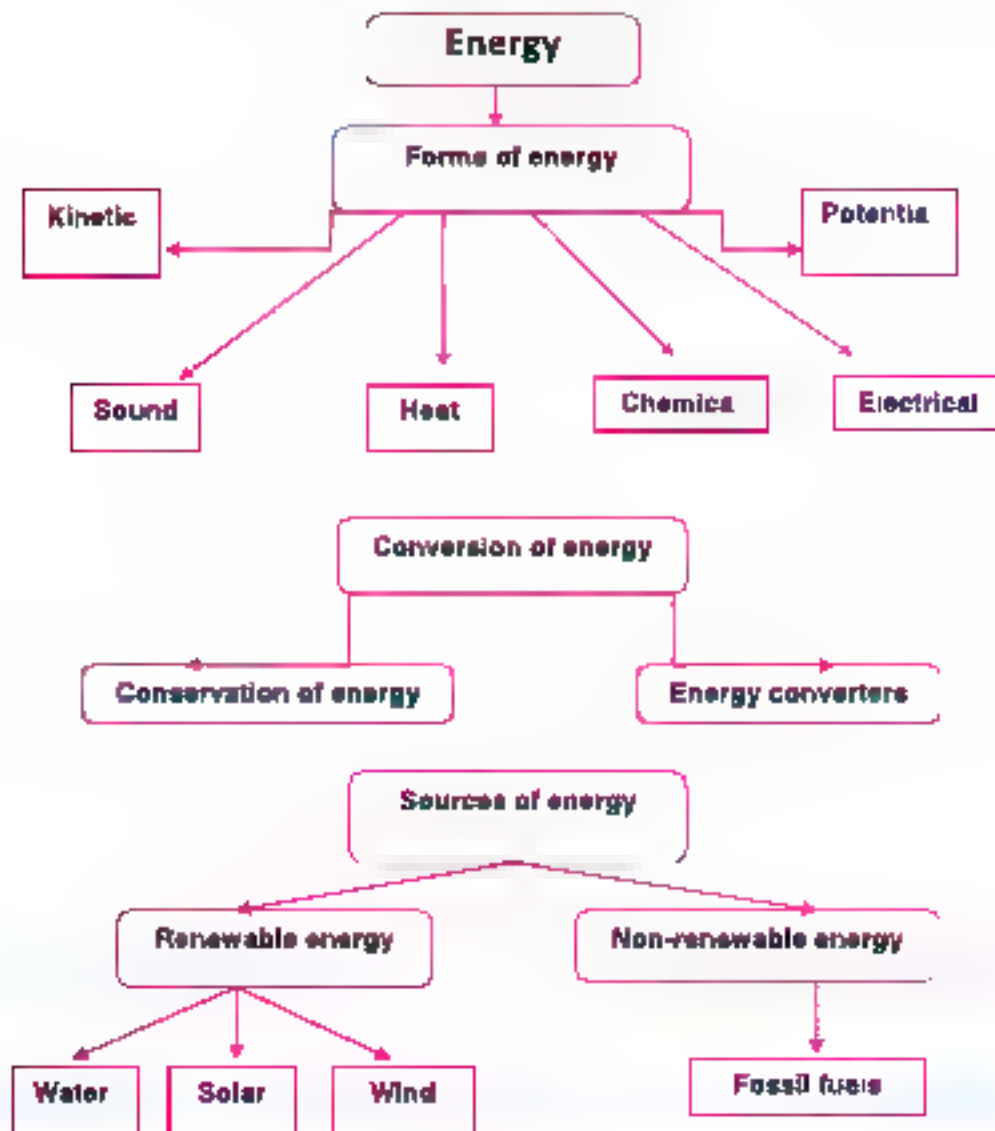
Now we return to the first thing we studied in this chapter: energy is not only in our environment, but inside of us as well. It gives the ability to do work, the more energy we have, the more work we accomplish. But how do we get this energy to do work?

Figure 8.11: Energy in our body

The answer is simple like there are various converters of energy present in and around our surrounding; our body is also a converter of energy. The food we eat and digest gives us chemical energy which our body converts to other forms. Like when we run, the chemical energy is converted into kinetic energy and some heat energy. When we speak or sing our body converts chemical energy to sound energy.

Activity 3 Can you name some more ways our body converts energy?

SUMMARY

Energy
Forms of energy
Kinetic
Potentia
Sound
Heat
Chemica
Electrical
Conversion of energy
Conservation of energy
Energy converters
Sources of energy
Renewable energy
Non-renewable energy
Water
Solar
Wind
Fossil fuels

Review Questions

Tick the correct answers

1. An example of kinetic energy would be

(a) A moving car (b) A person reading a book (c) A stretched spring

2. An example of potential energy would be

(a) A moving car (b) A stretched spring (c) A person reading a book

3. A toy car can move and make sound and runs on batteries. What type of energy is stored in the batteries?

(a) Chemical (b) Kinetic (c) Thermal

4. Imran and Ayesha are making a picture frame. Imran hits the nail into a piece of wood with a hammer. Which form of energy is not involved in the point, when the hammer hits the nail?

(a) Electrical (b) Kinetic (c) Sound

5. Briefly state the advantages of using renewable energy sources?

6. In the table below, write down the 3 differences between kinetic

Kinetic energy	Potential energy

9 FORCES AND MACHINES

What is a simple machine? How do simple machines make our work easier?

How are simple machines combined to make a compound machine?

Look at the following picture:

Figure 9.1 A Jeep

Can you name how many types of simple machines you may find in this jeep? Jeep is a type of a complex or a compound machine made up of many simple machines. Do you use any other type of complex machines?

In this chapter you will learn about:

- Wheel and axle, pulleys and gears are types of simple machines, which we use in our daily life
- Types of pulleys and its uses in our daily life and functions of pulleys
- Gears system and its function, uses of gears in our daily life
- How motion in the system of pulleys of different sizes is transferred to motion in another system of various gears in the same structure?
- The effort required by different gear systems to lift the same load.
- How the action of a pulley system is altered by changing the tension of the band connecting two pulleys.
- How to design and make a system of pulleys and gears for a structure that moves in a prescribed and controlled way and performs a specific function
- How to identify and make modifications to their own pulley and gear system to improve the way they move the load.
- How bicycle works?

All the students will be able to:

- ✓ Recognize wheel and axle and identify their uses.
- ✓ Describe pulleys systems and its kinds.
- ✓ Identify the uses of pulleys in daily life
- ✓ Describe the functions of pulley system and gear system.
- ✓ Describe how motion in the system of pulleys of different sizes is transferred to motion in another system of various gears in the same structure
- ✓ Investigate with the help of an experiment the effort required by different gear systems to lift the same load.
- ✓ Find out how the action of a pulley system is altered by changing the tension of the band connecting two pulleys.
- ✓ Design and make a system of pulleys and gears for a structure that moves in a prescribed and controlled way and performs a specific function.
- ✓ Identify and make modifications to their own pulley and gear system to improve the way they move the load
- ✓ Describe how a bicycle functions
- ✓ Identify common devices and systems that incorporate pulleys and gears.

WHEEL AND AXLE

✓ Recognize wheel and axle and identify their uses.

A wheel and axle is a special kind of lever, where the center of the wheel is the fulcrum. The two parts, wheel and axle, work together to turn or move a load when effort is applied. The **wheel** is the circular path the effort travels and the **axle** is the rod that goes through the center of the wheel. Wheel and axles are used to help us turn and move things easily. They can also help us change the size of movements. Changing the size of movements is very important, because it allows us to travel long distances without using too much effort. This can be seen in transportation, where wheels help vehicles travel long distances without requiring too much effort from the drivers.

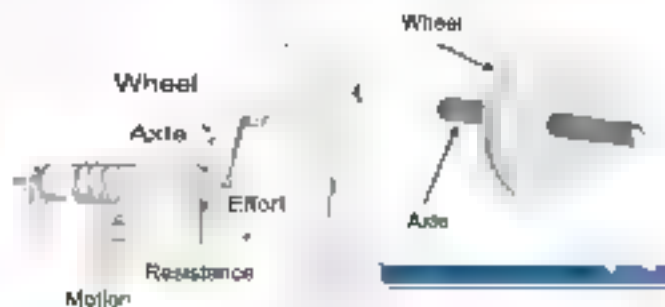
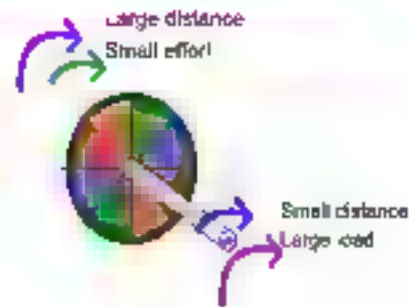



Figure 9.2: various wheel and axles

Uses of wheel and axle in daily life

Figure 9.3: Uses of wheel and axle in daily life (Fan, bicycle, motor, etc.)

✓Describe pulleys and their kinds

How do you hoist your national flag? Do you draw water from well? How do you lower and raise the bucket? Each time when you raise your national flag, or the bucket of water, you use a type of a simple machine called a **pulley**.

Figure 9.4(a). A pulley

A pulley consists of:

- A wheel which has a groove
- A belt or rope that runs inside the groove of the wheel.

In a simple pulley, on one end of the rope or belt is a **load (L)** and the other end is left free to apply **force (F)**. The diagram on the right shows a Fixed Pulley.

Fixed Pulley: When a pulley is hinged to a fixed support, it is a fixed pulley. A fixed pulley does not mean that it cannot move. It just cannot move up and down with the rope, but it is free to rotate around the fixed pivot.

Figure 9.4(b). A fixed pulley

In a simple pulley, on one end of the rope is a **load (L)** and the other end is left free to apply **force (F)**.
The working principle of the pulley is:

When one end of the rope is pulled downwards, the load on the other end of the rope is pulled upward.

Therefore, the **direction** of force is changed from downwards to upwards.
There is a pulley on the top of the pole of the flag which helps to raise the flag up.
The advantage is that the direction of effort needed to move the load is opposite to the load itself.

Movable Pulley

When a pulley is free to move up and down along with the load, it is called a movable pulley. This pulley can also rotate like the fixed pulley. The pulley shown in the figure on the right is a movable pulley. When an upward force F is applied by the hand the movable pulley moves up along with the load L. The advantage of a movable pulley is that the effort needed to move the load is less than the weight of the load.

Figure 9.5: A movable pulley

Double pulley system

Double pulley system consists of two pulleys with a rope running around them to lift a load. Using two or more pulleys reduces the amount of effort/force needed.

Figure 9.6: A double pulley

EXAMPLES OF PULLEYS

- ✓ Identify the uses of pulleys in daily life

Pulleys are used for drawing water from a well. A crane uses a pulley to lift heavy loads. An elevator uses a pulley to lift people. It uses a counterweight on the other end to do this.

There are more complicated pulley systems (mixture of fixed and movable pulleys) which enable you to lift quite heavy loads with a small effort. These are used on building sites, in shipyards, on sailing ships to lift heavy sails.

The more pulleys you have, the easier it is to move heavy loads

Do you know?

Pulleys have been around us for a long time. They were probably used for hauling up water in the Middle East around 1500 B.C.

Combinations of fixed and movable pulleys are also known as a block and tackle.

Some blocks and tackles have so many pulleys that they allow a single person to lift weights as heavy as that of a car!

Figure 8.7 A man lifting a large load using a pulley

Activity 1 Investigating how pulleys work

What I need

- 2 pulleys (fixed and movable)
- 1 wooden block
- 1 spring scale
- 1 piece of string
- Student Journals

What I do

1. **Measure** the weight of the wooden block by lifting it from the table with the spring scale without using a pulley. Record the reading in the given table.
2. Attach the wooden block to the string and pass the string to the fixed pulley. Attach the spring scale to the other end of the string and pull down.
3. Record the reading on the spring scale and note it down in the given table.
4. Attach the wooden block to the hook on the movable pulley.
5. Now tie one end of the string to the fixed point and pass its other end to the movable.
6. Then pass the string to the fixed pulley as shown in the figure. Now lift the block with the spring scale and note it down in the given table.

What I observed

Weight of the wooden block without lifting it with fixed pulley. (step 1	Weight of the wooden block lifting it with fixed pulley. (steps 2-3)	Weight of the wooden block lifting it with the two pulley system (steps 4 7)

Activity Questions

1. How much force do you predict will be needed to lift the load with the fixed pulley?
2. How much force was needed to lift the wooden block with the movable pulley?
3. What is the difference between the spring scale readings with or without pulleys?
4. Do you think the movable pulley will need more or less force or effort to move the load? Explain your answer
5. In which step you got the least spring scale reading? Explain.

Uses of Movable and fixed pulleys in daily life

Figure 9.8: Various daily life objects which use pulleys (Crane, alarm clock, bicycle, etc

Teacher's note Be sure that students pull straight down on the spring scale for accurate results. Arrange the materials in the presence of the students.

GEARS

✓ Investigate about the gear system and its uses in daily life

Gears are also important simple machines. A gear is just a wheel with teeth, sometimes called a **cog**. To do any work with a gear, you need to have at least two cogs with their teeth fitting into each other. Because the teeth fit together, when you turn one gear, the other one turns too. It can change the speed, direction, or amount of force needed to do work.

Figure 9.9: A gear

Gears come in many different sizes, which help them do work. You can save energy and make work easier by using gears.

You can have any number of gears connected together and they can be in different shapes and sizes. Each time you pass power from one gear wheel to another, you can do one of three things, i.e.

- **Increase force:** If the second wheel in a pair of gears has more teeth than the first one, it turns slower than the first one but with more force. See the figure at right.

12 Teeth
18 Teeth
B

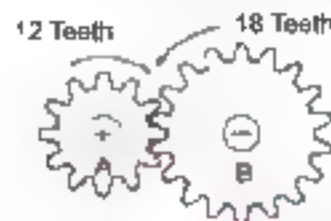



Figure 9.10: Increasing force of gear

- **Increase speed:** If you connect two gears together and the first one is large and has more teeth than the second one, the second one has to turn round much faster to keep up. So this arrangement means the second wheel turns faster than the first one but with less force.

- **Change direction:** When two gears mesh together, the second one always turns in the opposite direction. So if the first one turns clockwise, the second one must turn counterclockwise.

Gearing down

Gearing up

If you drive a large gear with a small gear, you can decrease the speed. It is called gearing down.

If you drive a small gear with a large gear, you can increase the speed. It is called gearing up.

If a gear gives you more force it must give you less speed at the same time. If it gives you more speed, it has to give you less force. That's why, when you're going uphill in a low gear, you have to pedal much faster to go the same distance. And when you're going straight, gears give you more speed but they reduce the force you're producing with the pedals in the same proportion.

Figure 9.11(a): Gears in watches

Figure 9.11(b): Gears in bicycle

Activity 2: Investigating how gears work materials

Figure 9.12 Handmade gears

- Cardboard box made of corrugated cardboard. Corrugated cardboard has the ridges inside
- Ruler, Pencil, Compass, sharp scissors, box cutter or razor, Glue and permanent markers.

Procedure

1. Cut out a piece of cardboard that is at least 8"x8". This will be your base.
2. On another piece of cardboard, use the compass to trace out at least four circles with 1 inch, 1.5 inch, 2 inch, and 3 inch diameters. Remember that a radius is half the diameter so if you set the compass radius at 1 inch, you will get a circle with a two inch diameter.
3. Cut out the circles you traced. The rounder your circles are, the better they will work.
4. Next, you are going to give each of your gears toothed edges. Making sure to cut along corrugates, cut a long strip of cardboard ¼" wide.

5 Jam your fingernail into the corrugate and carefully remove the brown paper on one side of the corrugated cardboard. You should be left with lots of bumps/teeth, without any paper still stuck on.
6 Cover your work area with newspapers to keep it clean
7 Spread glue around the edge of your first circle.
8 Roll the correctly measured piece of corrugated cardboard around the circle, making sure the bumps are on the outside and let it dry
9 Repeat for each of your other circles. Let all your circles dry completely.
10 Use a black permanent marker to make a black mark at one tooth of each of your gears. This way you will able to track when each has made a rotation.
11 Attach the 3-inch and 1 ½-inch gears to your board, using pushpin at the center of each and making sure that the gear's teeth interlock
12 Rotate the 3-inch gear clockwise and record in the table what happens to the 1 ½ inch gear
13 Using the black marks to keep track, turn the 2-inch gear once and record in the table how many times does the 1 ½ inch gear turn
14 Now, turn the 1 ½-inch gear once and record in the table how many times does the 3 inch gear turn.
15 Arrange the other gears as you wish, and experiment!

Observation:

When you rotate the 3-inch gear clockwise (step12)	When you turn the 2-inch gear once (step 13)	When you turn the 1½-inch gear once (step 14)

Activity Questions:

1 Which way does the 1 ½-inch gear turn when you rotate the 3-inch gear clockwise?
2 How many times does the 1 ½-inch gear turn when you turn the 2-inch gear once?
3 How many times does the 3-inch gear turn when turn the 1 ½-inch gear once?
4 What can you conclude from the activity?

Results: When you turn the 3-inch gear clockwise, the 1 ½-inch gear turns counter-clockwise. When you turn the 3-inch gear once, the 1 ½-inch gear goes around twice. When you turn the 1 ½-inch gear once, the 3-inch gear makes half of a rotation).

A BICYCLE

✓ How a bicycle functions?

Figure 9.13: A bicycle

Have you ever ridden a bicycle? What do you like about your bicycle? When you ride a bicycle, how is the energy that your legs generate used to push the bicycle forward? Do you know how does bicycle work?

Like all machines, a bicycle makes work easier. With a bicycle, it takes much less time to get to farther places.

A bicycle is made up of lots of parts. One bicycle could have more than 100 different parts. Each part of a bicycle has a function and a structure that helps the part perform its function well. A bicycle uses a kind of **pulley system** with a chain instead of a rope to carry the force on the pedals to the back wheel.

When you turn the **pedals,** the downward force of your legs is carried to the back wheel by the chain linking two gear wheels. When the pedals on a bicycle move, they turn the **gear**. When the gear turns, it moves the **chain**. The moving chain makes the **back wheel turn** and that pushes the bicycle forward. The **handlebars** are connected to the frame. On flat ground, gears attached to the wheels increase the distance a rider gets from one turn of the pedals, allowing him to cover a lot of ground quickly. On hilly terrain, gears give the rider more power when it is needed by lessening the distance the bicycle travels.

Figure 9.14(a): Parts of a bicycle

Back wheel

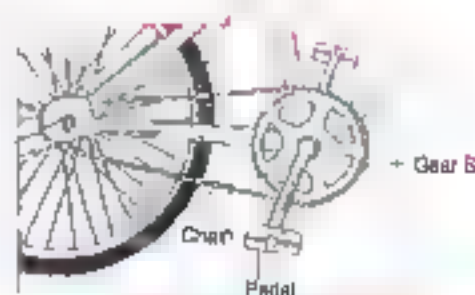
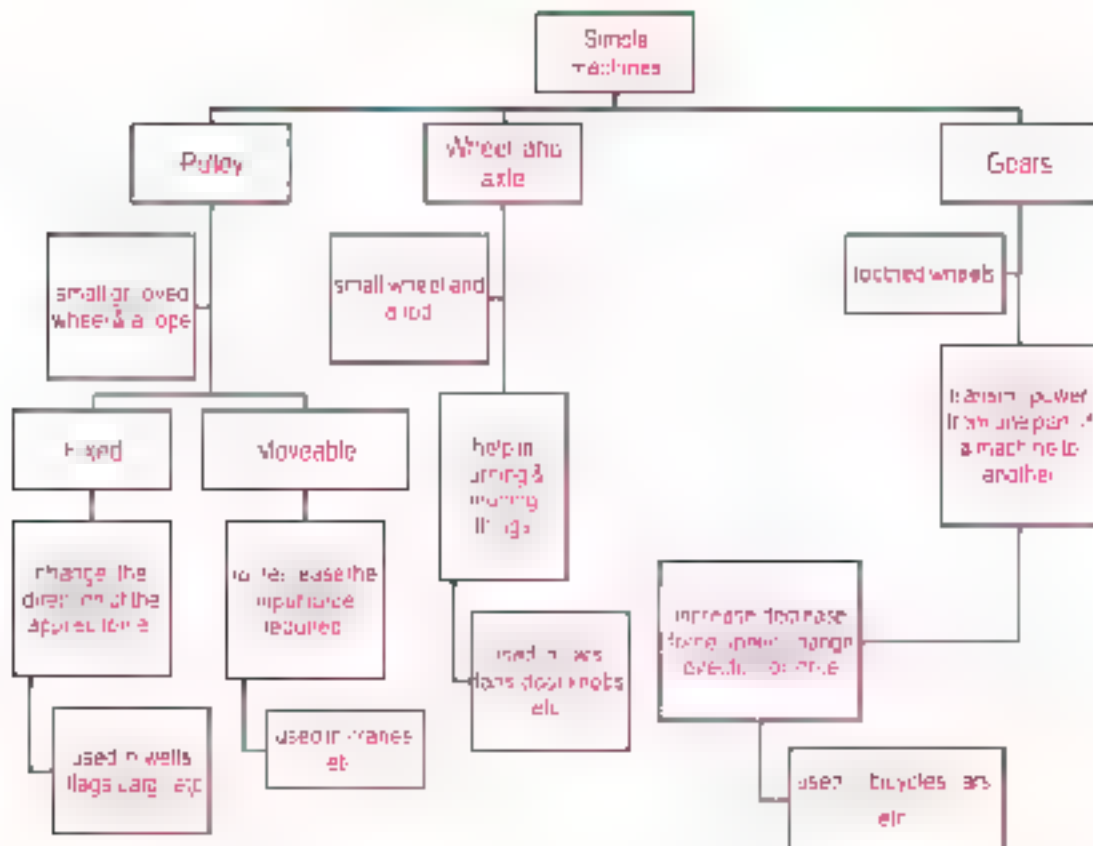
Gear B

Chain

Pedal

Figure 9.14(b): Parts of gears

SUMMARY

Simple machines
Pulley
Wheel and axle
Gears
small wheel and a rod
toothed wheels
Fixed
Moveable

Review Questions

Q 1 Tick the correct answer

i. **Which of the following is an example of wheel and axle?**

(a) Knife
(b) Car steering
(c) See-saw
(d) Bottle opener

ii. **Gears can do all of the following EXCEPT**

(a) change speed
(b) change direction
(c) change fulcrum
(d) change force

iii. **A movable pulley can**

(a) increase the input force
(b) decrease the input force
(c) change the direction of force
(d) change the speed of force

iv. **Which of the following use movable pulleys?**

(a) Flags
(b) Water wells
(c) Cranes
(d) Bicycles

v. **Which kind of simple machine is shown in the given picture?**

(a) Screw
(b) Pulley
(c) Inclined plane
(d) Wheel and axle

Q2 List the machines you may find in the bicycle.

____

____

____

____

Q3 Wheel and axle is a version of a lever. Justify.

Q4. Write TWO differences between fixed and movable pulley.

Q5 Look at the given diagram of gears. Gear A is moving clockwise. Draw the arrows in the diagram to show the direction of the movement of other gears.

Q6. Explain the working of a bicycle.

Q7 Write functions of the given simple machines.

S. No.	Simple machines	Functions
1	Pulley	
2.	Gear	
3	Wheel and axle	

INQUIRY

Find out at least one example of each of pulley, wheel and axle and gears in your home. Draw a picture of it, label its parts, and write what it is used for and how it is a simple machine.

PROPERTIES OF LIGHT

Can you see the world around you in complete darkness? What happened if there is complete darkness in your class room? Which part of the body enables you to see the objects present in your class room and why? It is your eye which gives you the sense of detecting the object in the presence of light. Light is a form of energy. As you have studied earlier, there are many sources of light such as fire, light bulb and ofcourse our sun.

- Transmission, absorption and reflection of light
- Law of reflection
- Types of reflecting surface
- Regular and diffused reflection
- Images formed by a plane mirror
- Uses of reflecting surfaces (periscope, telescope and microscope)
- Multiple reflections (kaleidoscope)
- Types of mirror (plane, convex and concave mirrors) and their uses
- Images formation in convex and concave mirrors

All the students will be able to

- ✓ Differentiate between transmission, absorption and reflection of light
- ✓ Demonstrate the law of reflection
- ✓ Demonstrate the difference between smooth, shiny and rough surfaces
- ✓ Compare the regular and diffused reflection
- ✓ Identify everyday application, which involve regular and diffused reflection
- ✓ Draw ray diagrams for light reflected from a plane mirror at different angles of incidence
- ✓ Describe image formation by a plane mirror
- ✓ Compare characteristics of the images formed by a plane mirror and a pinhole camera
- ✓ Explain the uses of reflecting surface in different devices
- ✓ Design an experiment to make an optical instrument using mirror
- ✓ Explain the principle of reflection in a kaleidoscope
- ✓ Describe the relationship of an angle between two mirrors and a number of images they can see in kaleidoscope
- ✓ Explain types of mirror and their uses in our daily life
- ✓ Investigate the image formation by convex and concave mirrors

Do you know?

1. Light travels in straight lines and can be made to change its direction when an object in its path reflects the beam.
2. You see an object because light travels from a light source to the object and is then reflected off the object and travels to your eyes.
3. Different types of objects reflect different amounts of light. In addition to reflection, light also can be partially absorbed or transmitted by an object.

TRANSMISSION, ABSORPTION AND REFLECTION OF LIGHT

✓ Differentiate between transmission, absorption and reflection of light

Figure 16.1 A man in black clothes

Have you ever worn a black shirt on a sunny day? Or walked barefoot on black pavement on a summer afternoon? You may have noticed that these black substances became very hot. What causes the buildup of heat?

Absorption of light:

Figure 16.2 Light waves absorbed by surface

It occurs when light comes in contact with a substance and is engulfed. When light waves strike an absorptive substance, their energy is transferred into heat. Thus, you can tell when a substance has absorbed light because it heats up.

Activity 1 Absorption of Light

[illegible]

- Two thermometers, Construction paper (half sheets of black and white paper) Stapler, Scissor.

Procedure

Work in pairs. Start with a half sheet of black and white construction paper. Fold each sheet in half lengthwise to form a pocket. Use a stapler to secure the shape of these two pockets. Place a thermometer in each pocket. Make sure that each thermometer fits completely within its sleeve. Place the pockets the shade. Wait 10 minutes. Quickly observe and record the temperature shown by each thermometer. Return them to their appropriate pockets. Place both pockets in

direct sunlight. Every five minutes, observe and record the temperature displayed by each thermometer. Make a table to display your results.

Questions

1. Which of the two pockets absorbed the most light?
2. Which pocket showed the fastest temperature rise? Why?
3. Which pocket showed the slowest temperature rise? Why?

Reflection of light:

You may have noticed the appearance of sky in pools of water or you probably use a mirror every day to see your face. What causes these?

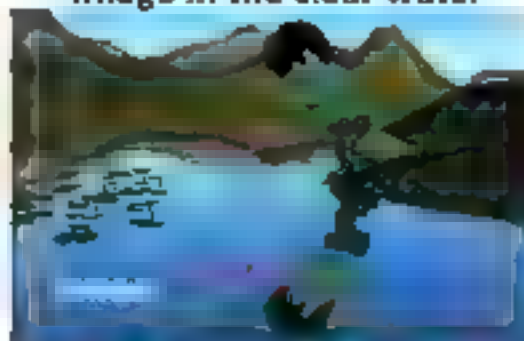



Figure 10.3: Reflection in water

Reflection occurs when light bounces off a shiny surface. The waves of light come in contact with the surface and then bounce back off at the same frequency and angle. As a result, reflected light allows us to see mirror images of the world around us.

Figure 10.4: Reflection of light

Activity 2 Reflection of light

Material

3 Plane mirrors, flashlight, a target

Procedure

1. In this experiment you have to get the flashlight onto the target (without directly pointing at the target) by using the 3 mirrors to reflect light.
2. Place the 3 plane mirrors in such a way that when the flashlight is aimed at one mirror it reflects light on to the other mirror, and finally reflected light hits the target.
3. When all 3 mirrors are placed correctly the light will hit the target.

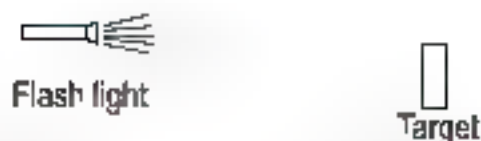



Figure 10.5 Flashlight hitting the target

Questions

1. At what angles the three mirrors should be placed to reflect light to the target?
2. What other objects could be used to reflect light like a mirror?

Transparent materials often allow transmission of some types of light but not others. For example, glass allows the transmission of visible light but not ultraviolet light, which is why you don't get sunburn by sitting inside a sunny window.

LAW OF REFLECTION

✓ Demonstrate the law of reflection

Light is transmitted through substances (such as glass) which we think of as transparent. **Transmission** occurs when light passes through a substance unchanged.

Light is known to behave in a very predictable manner. If a ray of light could be observed approaching and reflecting off of a flat mirror, then the behavior of the light as it reflects would follow a predictable law known as the **law of reflection**.

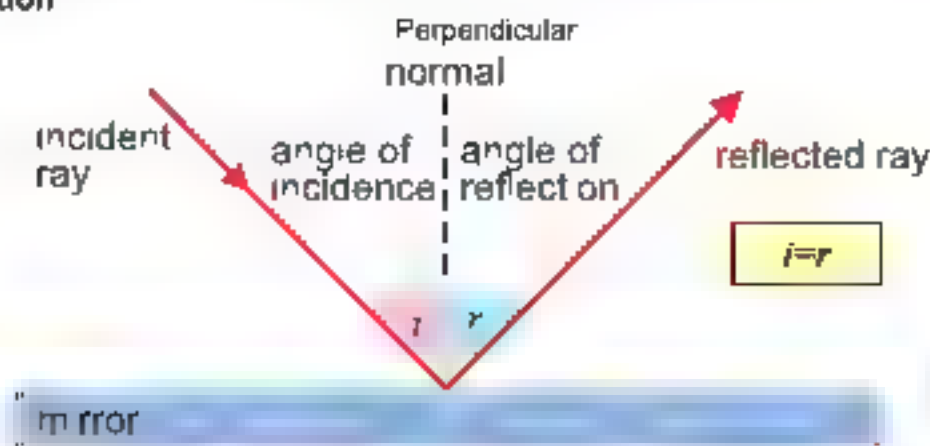



Figure 10.6: Light wave being reflected

The law of reflection states that "when a ray of light reflects off a surface, the angle of incidence is equal to the angle of reflection".

Activity 3: Investigating reflection in a plane mirror

Material

A plane mirror, mirror holder, laser light/torch

Procedure

Fix a small piece of mirror in a holder and make laser light incident on it. Observe if light ray comes back or not. Draw the dotted line on the path of ray of light. Mark the point where the laser beam hits the surface. Use chalk dust to observe the reflected beam. Carefully draw perpendicular to the surface using protractor and measure angle of incidence and angle of reflection.

Questions

1. Is angle of incidence equal to angle of reflection?
2. What do you conclude about the relationship between angle of incidence and angle of reflection?

TYPES OF REFLECTING SURFACES

- Demonstrate the difference between smooth, shiny and rough surfaces

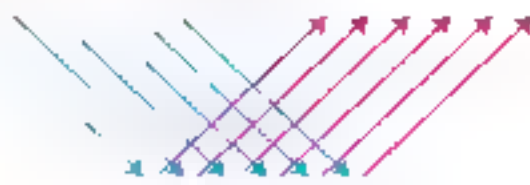
When a parallel beam of light rays strikes a smooth surface like mirrors, it will be reflected as parallel rays of light. This type of reflection is called regular or specular reflection. Polished metal surfaces, calm surface of a lake and mirrors are the examples of such reflection.

Specular Reflection
(smooth surfaces)

Figure 10.7: Light reflected off a smooth surface

When parallel rays of light fall onto a rough surface they are reflected in different directions and are scattered. This reflection is called diffused, irregular or scattered reflection. In this reflection no regular images are formed.

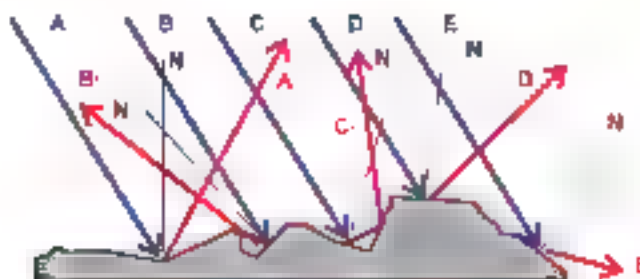



Figure 10.8: Light reflected off a rough surface

Difference between Rough, Smooth and Shining Surfaces.

When light strikes a smooth and shining surface (like a mirror), it is reflected at the same angle. When it hits a rough surface (like a sheet of paper) it is diffused, meaning the rays of light are scattered.

Activity 4 Reflection from regular and irregular surface

Material

Aluminium foil and a trough of water

Procedure

Take a neat sheet of aluminium foil and see your face in that sheet.

Can you see your image clearly?

Now distort your foil and again see your face in the paper.

What you see? Fill a trough with clear water and see your reflection in it, now dip your finger in water and again see your reflection in water.

Questions

1. What is the difference in images of neat and distorted aluminium foil sheet?
2. Did every material reflect light in the same way?
3. What is the difference in images of clear water and ripple water?

APPLICATIONS OF REGULAR AND DIFFUSED REFLECTION

- Compare the regular and diffused reflection.
- identify everyday application, which involve regular and diffused reflection.

There are many interesting applications of the distinction between regular and diffuse reflection. One application pertains to the relative difficulty of driving at night, on a wet asphalt roadway compared to a dry asphalt roadway. Normally

a roadway would cause diffuse reflection due to its rough surface but driving at night on a wet roadway results in an irritating glare from oncoming headlights. The glare is the result of the regular reflection of the light rays from an oncoming car. Another application of irregular diffuse and regular reflection pertains to the field of photography. The calm water provides for the regular reflection of light from the subject of the photograph. Since the light reflecting off the water undergoes regular reflection, the incident rays remain concentrated instead of diffusing.

A dry asphalt roadway diffuses incident light.

When wet, water fills in the crevices, resulting in specular reflection and a glare

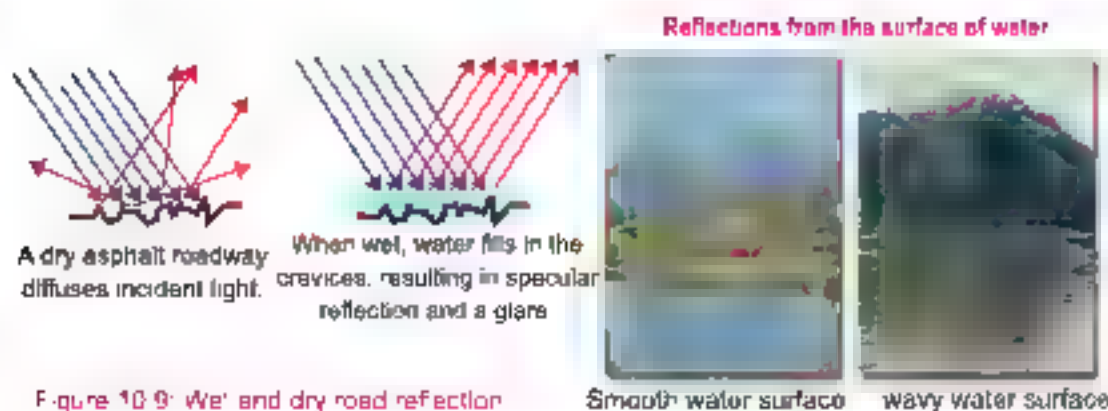



Figure 10.9: Wet and dry road reflection

Reflections from the surface of water

Smooth water surface   wavy water surface

Figure 10.10: Light reflection in water

IMAGES FORMED BY A PLANE MIRROR

- Draw a ray diagrams for light reflected from a plane mirror at different angle of incidence.
- Describe image formation by a plane mirror

Mirrors are extremely good reflector because they are very smooth and shiny. If the reflecting surface of the mirror is flat then we call this type of mirror as **plane mirror**. Light always has regular reflection on plane mirrors.

We see images in a plane mirror when light rays from objects are reflected by the mirror into our eyes. The figure 10.11 shows how, by reflecting light, a plane mirror forms an image of a person standing in front of a plane mirror.

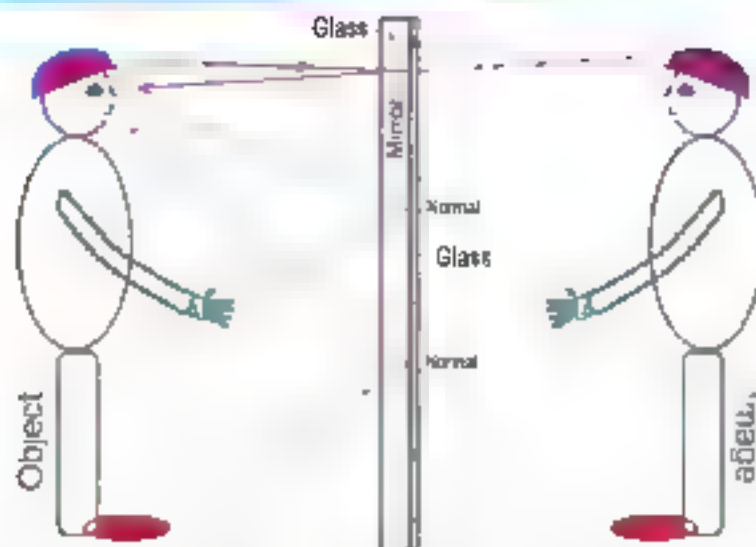



Figure 0.11 How a plane mirror forms an image

In plane mirrors, we use the laws of reflection while drawing the image of the objects. As you see from the picture we send rays from the top and bottom of the object to the mirror and reflect them with the same angle it hits the mirror. The extensions of the reflected rays give us the image of our object. The orientation and height of the image is same as the object. In plane mirrors always virtual image is formed.

Example: Find the image of the given object.

Mirror

B

A

C

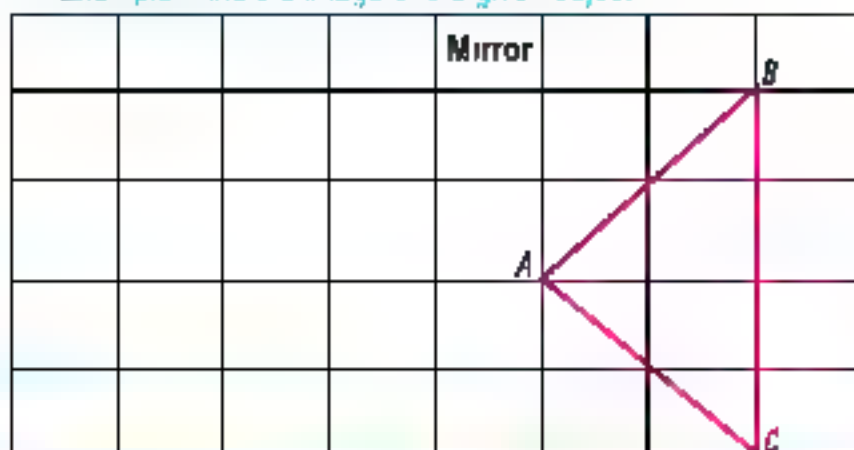



Image of the object is formed behind the mirror with the same distance of object. First draw point A′ which is the image of point A, place it one unit away from the mirror, then points B′ and C′ are placed with the same way. Connect these 3 points and the image of object is formed. The dashed line in the left side of the mirror is the image.

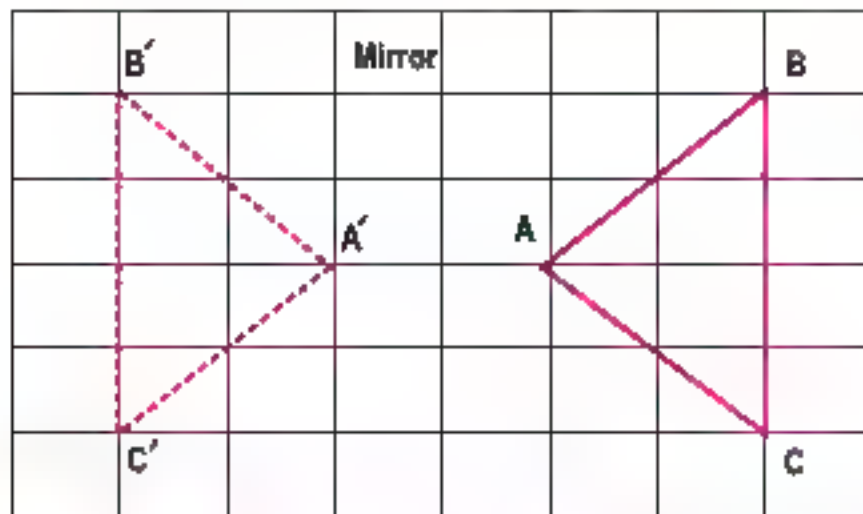



Figure 10.12 : Image in plane mirror

Figure 10.13: An ambulance

Do you know?

The word 'AMBULANCE' is often printed laterally inverted on the front of ambulance so that it can be easily read by the drivers from rear-view mirrors.

COMPARISON OF IMAGES FORMED BY A PLANE MIRROR AND BY A PINHOLE CAMERA

- ✓ Compare characteristics of the images formed by a plane mirror and a pinhole camera
- ✓ Explain the uses of reflecting surface in different devices
- ✓ Design an experiment to make an optical instrument using mirror

Plane mirror	Pin hole Camera
Virtual	Real
Lateral inversion (left to right)	Vertical inversion (upside-down)
At the same distance	Distance vary
Same size	Generally smaller than the object

Reflecting Surfaces and their uses.

How many times do you look your face in the mirror in a day? Besides being used to check our appearance, plane mirrors have many other uses.

Plane mirrors are used in many types of optical instruments as reflector. The purpose of plane mirrors in these instruments is to change the direction of light. Some of the examples of such instruments we see in our daily life are Microscopes, Telescopes, Periscope and Kaleidoscope

Figure 10.14 Mirror is used for the reflection of light into the microscope

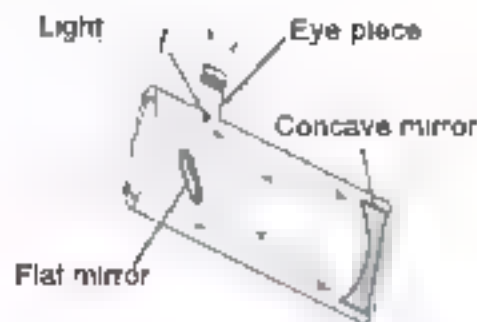



Figure 10.15 A mirror is used for the reflection of light in to the reflecting telescope. It is used to examine the visible light

Do you know?

The world's largest reflecting telescope has such a big concave mirror that it can detect a lighted candle more than 20000 km away!

A Periscope uses two plane mirrors one above the other at 45^0. The purpose of these mirrors is to reflect light and change its direction. It is used in submarines to monitor the surface of water from the depth of water.

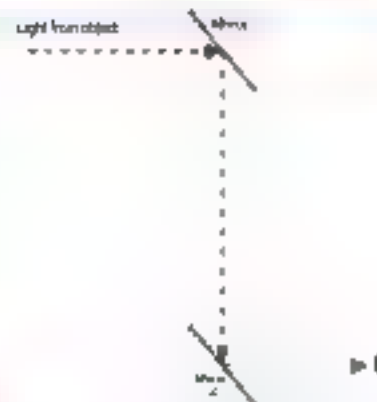



Figure 10.16: A periscope

KALEIDOSCOPE

- ✓ Explain the principle of reflection in a kaleidoscope.
- ✓ Describe the relationship of an angle between two mirrors and a number of images they can see in kaleidoscope

A Kaleidoscope is a tube used for multiple images of the objects. It consists of two or more plane mirrors inclined to each other. Kaleidoscope operates on the principle of multiple reflections, where several mirrors are placed at an angle to one another (usually 60°). Typically there are three rectangular mirrors set at 60° to each other so that they form an equilateral triangle. Coloured beads or any other coloured objects are placed in between the mirrors. On turning the tube constantly changing pattern is observed every time due to multiple reflections of the coloured objects.

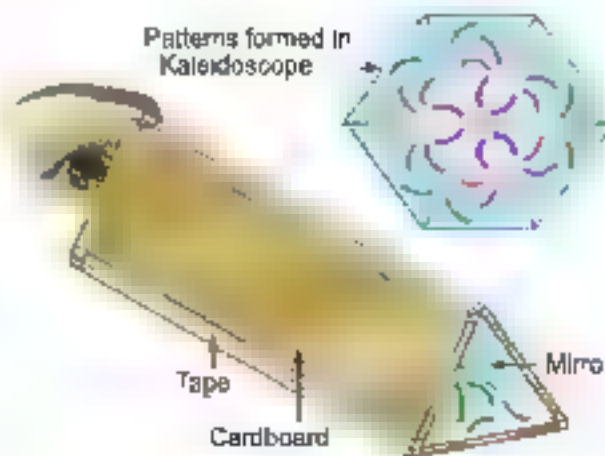



Figure 10.17: A kaleidoscope

Activity 5 Making of a Kaleidoscope

Materials

Mirror strips three (1inch x 4inch). Card sheet, glue and beads, transparent white cellophane sheet.

Procedure

Paste a mirror strips on card sheets of same sizes

Join these mirrors at an angle of approximately 45 degree.

Put stone beads in it and cover it with cellophane

Questions

1. When you see in the kaleidoscope and rotate what you see?
2. Why see multiple images?

CONCAVE AND CONVEX MIRRORS

- ✓ Explain types of mirror and their uses in our daily life.
- ✓ Investigates the image formation by convex and concave mirrors.

Plane mirrors have flat reflecting surfaces, but there exist reflecting surfaces which are not flat. Have you ever noticed the image of your face formed in a metal spoon? Do the front and back side of the spoon produces the same image? A mirror which has a reflecting surface that curves inwards like the front side of the spoon is called **Concave mirror** while the one which bulges outwards like the back side of the spoon is called **Convex mirror**. Both of them are spherical mirrors.

Figure 10.18: A spoon

When an object is placed very close to a Concave mirror its image will be
1. Virtual
2. Upright
3. Larger in size than the object

However, if the object is placed far away from the concave mirror then the image formed will be
1. Real
2. Inverted
3. Smaller in size than the object

Concave mirrors are used in vehicle headlights to send parallel rays because it allows the light rays to be focused as a single beam and give more power to the light. They are also used as shaving and make-up mirrors to have a larger view of the face. Another important use of concave mirrors is in reflecting telescopes, they are optical telescopes that use either 1 concave mirror or a combination of them that reflect light from an image. Concave mirrors are also used in dentist mirrors because they produce high magnified pictures that are useful to see a lager view inside the mouth.

Cosmetic mirror

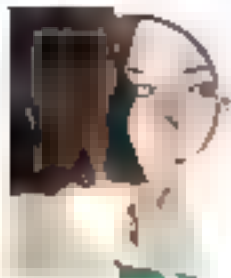



Figure 10.19: Convex mirrors

Car headlight

Reflecting telescope

Figure. 10.20: Concave mirrors

Dentist mirror

Convex mirrors, due to its wider viewpoint of smaller space are used in cars as rear-view mirrors. They are also used as security mirrors in shopping mall and blind corner mirrors on road.

Reare-view mirror

Blind corner mirror

Security mirror

[illegible]

1. **Fill in the blanks.**
   a) Light travelling in a straight line______________ when it strikes the surface of another medium.
   b) The image formed by a plane mirror is ____________ in size to the object
   c) _________ mirrors are used for shaving and make-up purposes.
   d) A ____________ is used in submarines to monitor the surface of water
   e) ____________ mirrors are used as security mirrors in shopping malls
2. **Classify the following into two groups - 'Light sources' and 'Non-light sources'**
   Star, Moon, Sun, mirror, electric torch, diamond, table lamp, boy, burning candle, lightning, table, and television (switched on)
3. **What is absorption and reflection of light?**
4. **Which type of surface produces**
   a) Regular reflection b) Irregular reflection?
5. **Give three uses of each concave mirror and convex mirror**
6. **What are the characteristics of the images formed by a plane mirror?**
7. **When light is reflected in a plane mirror, what is special about the angles of the incident and reflected rays?**
8. **Why do diamonds sparkle from so many directions and in so many colours?**
9. **Why could you not use a concave mirror as a rear-view mirror in a car?**
10. **If a driver has one plane mirror and one convex rear-view mirror, how would the images formed in each appear different?**

INVESTIGATING SOUND

Sound plays an important role in our life. It helps us to communicate with one another. We hear a variety of sounds in our surroundings. Can you make a list of sounds you hear in your surroundings?

Activity 1

List of sounds

WHAT IS A SOUND?

✓ Describe sound as a form of energy

Sound is a form of energy produced by the vibrating objects and spread in all directions. The vibrating objects cause the medium (solid, liquid or gas) around it to vibrate. More the energy used faster they vibrate and higher the sound they produce. The air column in the whistle vibrates so fast which produces the whistle sound. Aeroplane when moves through the air with speed it causes great vibrations and produces lot of sound.

- Sound is the form of energy
- Sound travels in waves
- Sound waves consist of rarefaction and compression.
- Speed of sound in different materials.
- How do we listen sound waves

All the students will be able to.

- ✓ Describe sound as a form of energy
- ✓ Compare the speed of sound in solids ,liquids and gaseous medium.
- ✓ Identify a variety of materials through which sound can travel.
- ✓ Explain that how does a human ear receive sound

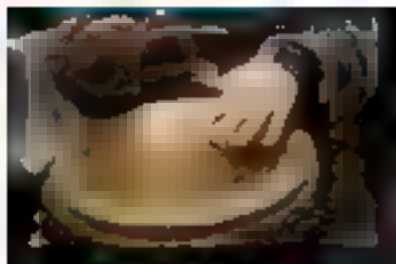



Figure 11.1: A drum

Hitting the skin of the drum causes it to vibrate and create sound waves. When the sound waves reach your eardrums they vibrate too.

When the tuning fork is struck on the rubber pad and touched on the surface of water, water is splashed out. Can you explain why?

A micro phone is a device which converts sound (acoustical) energy into electrical energy. When the sound waves strike the diaphragm it vibrates. These vibrations are converted into an electrical current which becomes the audio signal.

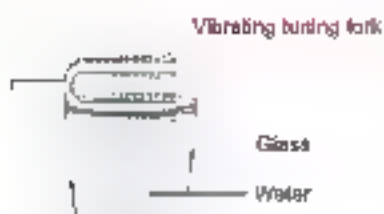



Figure 11.2: Tuning fork and water

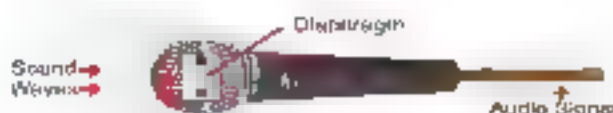



Figure 11.3: A microphone

What I need

- Wooden, plastic and metallic rulers, rubber band.

What I do

1. Fasten a rubber band to a doorknob, pull it and pluck it and record your findings in the given table.
2. Place half of the metal ruler on the desk or table with your palm with the ruler extending over the side.
3. Pull the ruler down and let go and record your findings in the given table.
4. Repeat steps 2 and 3 with the plastic ruler and wooden ruler.
5. Ask students to share their findings with the whole class.
6. Discuss what happens when the rubber band is plucked.
7. Discuss what happens when the ruler is let go.

What I observed

Wooden ruler	Metal ruler	Rubber band	Plastic ruler

What I conclude

How does sound travel?

How do you hear your school bell? How do you hear Azaan five times in a day? How does each of these sounds get to your ears? Sound travels in the form of waves called longitudinal waves. Sound wave is a longitudinal pressure wave of audible or inaudible sound. When any object vibrates, it causes the air particles around it to vibrate. The particles hit the other air particles and make them to vibrate. This causes them to hit into more air particles. This continuous movement of air particles called sound waves.

As the air particles move by the vibrations of the particles, it forms rarefactions (when particles are far apart) and compressions (when particles are closed or crowded).

Teacher's Note: The teacher needs to arrange the materials. Divide students in groups of five according to the strength of the class. Provide each student with the materials. Ask them to produce a sound with each materials provided to them and use them in different ways for producing the sounds.

Look at the figure of the loud speaker below

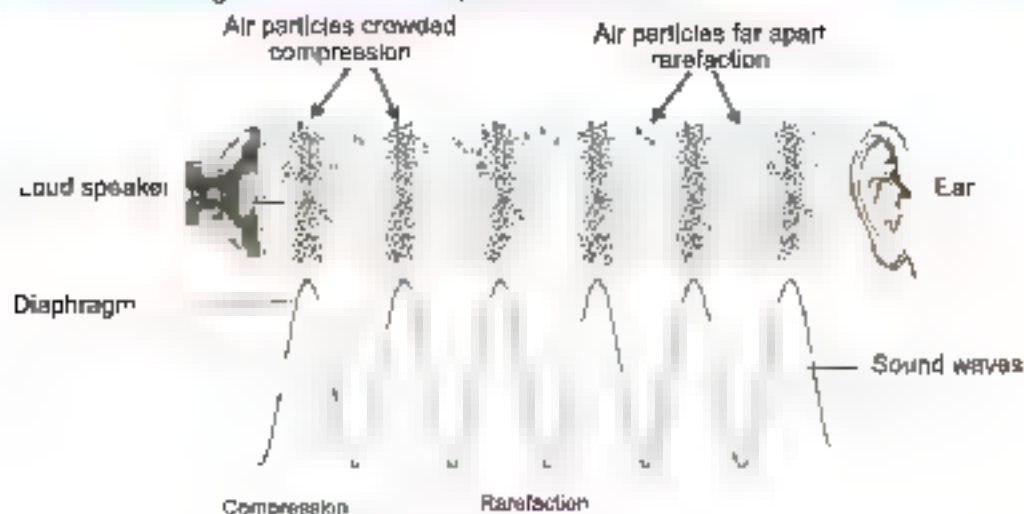



Figure 11.4 A loudspeaker

When the diaphragm of the loudspeaker vibrates, it causes air particles around it to vibrate. The diaphragm bends inward and outward very rapidly. As the diaphragm moves outward, it pushes against particles of air. Those air particles then push against other adjacent air particles, and so on. As the diaphragm bends inward, it pulls against the adjacent air particles, and they, in turn, pull against other air particles. This push and pull pattern form regions of compression and rarefaction in the longitudinal waves.

A **compression** is a region in a longitudinal wave where the particles are closest together.

A **rarefaction** is a region in a longitudinal wave where the particles are furthest apart.

Do you know?

Hyper sonic sound technology is simply the most revolutionary sound reproduction system of this century. It gives you the ability to direct sound where you want. Imagine different people in a room or a car listening to completely different music or watching different shows without using headphones or fighting over controls. Special loudspeakers are used to focus and direct the sound waves and control their dispersion.

HOW DOES SOUND TRAVEL IN DIFFERENT MEDIUMS?

✓ compare the speed of sound in solids, liquids and gases.

A class fellow is to be sent to the next room to hit the wall with a small stone. Now hear the sound made by your class fellow by placing ear on the wall. Next place a glass on the wall and hear the sound through glass. Yes, this trick really does work. The sounds in the next room are transmitted through sound waves into the wall, which absorbs most of the vibrations. The glass can help you pick up the vibrations directly from the wall and amplify them straight into your ear. You can't hear perfectly, but you can definitely hear more with the help of glass.

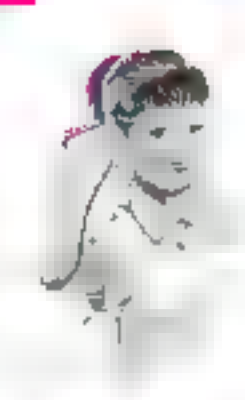



Figure ... : Girl listening through a glass

Activity 3 Identifying the materials through which sound waves travel

What I need Bucket or tub, bell, water, and a wooden ruler

What I do

1. Take a tub and fill it with clean water.
2. Take a small bell in one hand. Shake this bell inside the water to produce sound. Make sure that the bell does not touch the body of the bucket or the tub.
3. Now listen to the sound. How is the sound from bell reaching your ear? Which medium are the sound waves travelling to reach your ear?
4. Record your finding.
5. Now take a meter scale or a metal rod and hold its one end to your ear.
6. Ask your friend to gently scratch or tap the other end of the scale.
7. Record your finding in the given column.

What I find.

When the bell is rung in water	When the ruler is scratched

Activity Questions

1. Do you hear sound of scratching the ruler? Why?
2. What happens when the bell is ringing inside the water?
3. What do these activities indicate?
4. What do you conclude?

In the above activity you have observed that the sound waves can travel through air, water and solid. It shows that sound travels through a medium but it cannot travel through space. Sound waves require a medium to travel. Outer space is a vacuum and therefore it is silent.

Do you know?

Marin Mersenne was the first to measure the speed of sound in air 1640, **Robert Boyle** discovered that sound waves must travel in a medium.

Speed of sound

If you have ever been to a cricket match you may have noticed something odd. You see the batsman hit the ball, but did not hear the sound of hitting the ball until a few seconds later. This is because the speed of sound is slower than the speed of light, which we are used to see. The same thing is at work during a thunderstorm. Lightning and thunder both happen at the same time. We see the lightning almost instantaneously, but it takes longer to hear the thunder.

Why do we see lightning before the thunder?

The flash of light from lightning travels at about 300,000 kilometers per second. This is why we see it so much sooner than we hear the thunder. If lightning occurs a kilometer away, the light arrives almost immediately (1/300,000 of a second) but it takes sound nearly 3 seconds to arrive.

Next time whenever you see lighining count the number of seconds before the thunder arrives.

The speed of a sound wave refers to how fast the disturbance or wave is passed from particle to particle The speed of sound depends on the medium the sound is traveling through. A sound wave will trave faster through a dense medium rather than through a less denser medium Sound travels faster through solids than through liquids and faster through liquids than through gases. This is because the density of solids is higher than that of liquids which means that the particles are closer together and sound can be transmitted more easily The speed of sound also depends on the temperature of the medium. The hotter the medium is the faster its particles move and therefore the quicker the sound will travel through the medium.

Speed of sound in different materials

Substances	m/s
Aluminium	6420
Brick	3650
Copper	4760
Glass	5100
Gold	3240
Lead	2160
Sea water	1530
Air	332

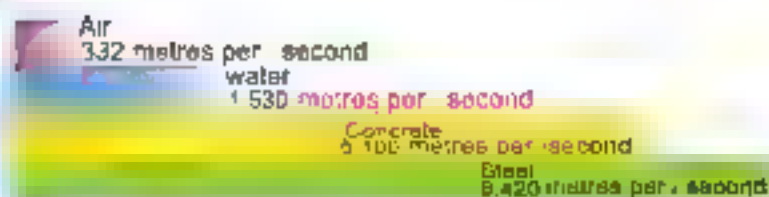



Figure 11 6 Speed of sound in different mediums

HOW DO WE HEAR?

✓ Explain how the human ear receives sound

Did you hear something right now? May be the sound you heard was as quiet as the ceiling fan or maybe it was loud like a school bell. Sounds are everywhere and you have your two parts of your body that let you hear them all: yes, your ears. Have you ever thought about how you hear sounds?

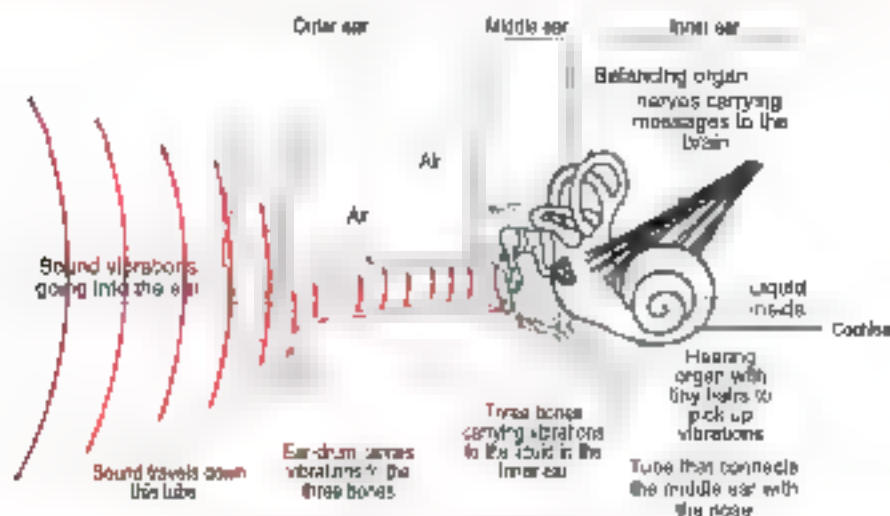



Figure 11.7 How the ear receives sound

As we have studied the parts of human ear, sound waves enter the ear canal and make the ear drum vibrate. This action moves the tiny chain of three bones in the middle ear. The last bone in this chain is stirrup, 'knocks' on the membrane window of the cochlea which contains hair cells and makes the fluid in the cochlea move. The fluid movement then triggers a response in the hearing nerve. Thus we sense a sound.

Do you know?

A sound, especially one that is loud or unpleasant or that causes disturbance is called noise. Noise intensity is measured in decibels. A sound level meter is used to measure the decibel level of sound. Noise level 85 or above may cause hearing loss which is due to the damage of hair cells in an inner ear.

SOUND

Cannot travel in

Travels in waves

Waves

in solids

In air is 332 m/s

Can travel in air

Q1 Tick the correct answer

i) In which of the following, speed of the sound is maximum?
   a) Sea water
   b) Air
   c) Gold
   d) Space

ii) When sound travels through air the air particles
   a) vibrate along the direction of wave propagation
   b) vibrate but not in any fixed direction.
   c) vibrate perpendicular to the direction of wave propagation.
   d) vibrate and move in a straight line.

iii) Sound waves first enter the
   a) ear drum
   b) ear canal
   c) cochlea
   d) stirrup

iv) The speed of sound in air is
   a) 345 m/s
   b) 333m/s
   c) 332 m/s
   d) 354 m/s

v) When sound waves reach the ear drum:
   a) sound is sensed by the brain.
   b) small hairs in the cochlea detect the vibration from the ear drum.
   c) the auditory nerve detects the vibration and sends them to the brain
   d) small bones that lie behind the ear drum carry the vibration to the liquid in the inner ear

Q2 Complete the flow chart showing the passage of sound wave when it enters in the ear canal and reach the brain

Q3 Identify the parts which vibrate to produce sound in the following objects.

Q4. a) What is sound and how is it produced?

b) Describe with the help of a diagram, how compressions and rarefactions are produced in air near a source of sound.

Q5. Write one word answer for each of the following.

a) Rapid back and forth movement of an object ______________

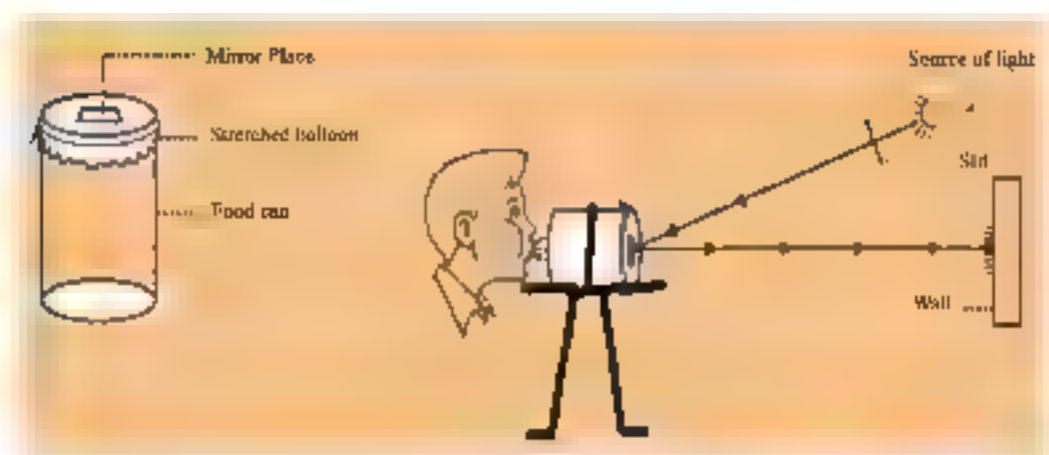
b) A region in a longitudinal wave where the particles are closest together ______________

c) A region in a longitudinal wave where the particles are furthest apart ______________

d) The last bone in the tiny chain of three bones in the ear ______________

Q6. **Extended learning activity**

Can sound make a light spot dance?

i. Take a tin can and remove both ends to make it a hollow cylinder.
ii. Take a balloon and stretch it over the can, then wrap a rubber band around the balloon.
iii. Take a small piece of mirror. Use a drop of glue to stick the piece of mirror to the balloon.
iv. Fix the tin on a stand.
v. Allow the light through a slit to fall on the mirror.
vi. After reflection the light spot is seen on the wall, as shown in the given figure.
vii. Talk or shout directly into the open end of the can and observe the dancing light spot on the wall.
viii. Discuss with your friends what makes the light spot dance.

A beam of light from a light source is made to fall on a mirror. The reflected light is falling on the wall.

Project

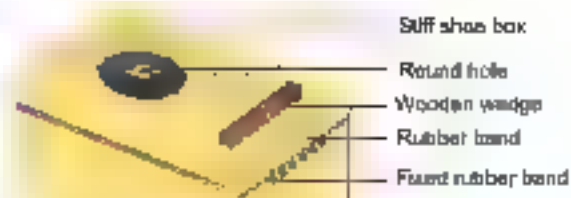
Have you ever thought about how a guitar works? In this science experiment, we will explore exactly how guitars produce music!

Material required

Shoebox, Rubber bands, Drawing pins, Wooden wedge, Glue, Scissor

Method:

1. Find a shoebox made out of very 'stiff' cardboard. Draw a circle on the top of the lid of a shoebox that is about 8 cm in diameter and cut a hole on the line. This is called the 'sound hole' and is usually in the center of the 'sound box' of a guitar.
2. Choose some rubber bands of various thicknesses in the order of thick to thin and pin them to the sides of the shoebox as shown in the figure.
3. Glue the wooden wedge under the rubber bands as shown in the figure.
4. Your guitar is ready now to play.

12 SPACE AND SATELLITES

What are celestial bodies and satellites? What is the difference between natural and artificial satellites? We all know that the Sun, Moon, stars and planets like Earth, Mars, Jupiter are celestial (naturally existing) bodies of our solar system.

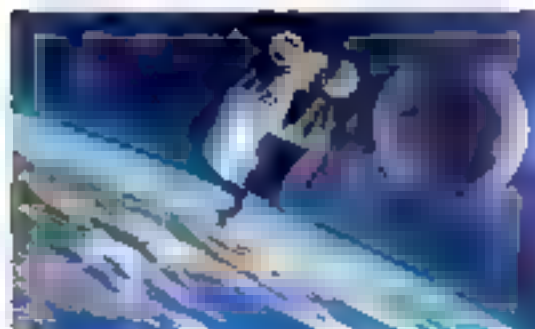



Figure 12.1 Natural and Artificial satellite

If a celestial body moves around a planet or a star, it is called a natural satellite of that planet or star. For example, Moon is a natural satellite of Earth. The outer space has many more natural satellites like Moon.

The existence of these natural satellites in the space encouraged man to develop artificial satellites for the benefit of their home planet Earth and other Space exploration purposes. Today hundreds of artificial satellites are operating in space for various applications. In this chapter, we shall study more about satellites, their types and uses.

- Space and satellites
- Natural satellites of planets and sun
- Artificial and geostationary satellites
- Types of artificial satellites

All the students will be able to

- ✓ Define the term satellites
- ✓ Define the terms artificial and geostationary satellites
- ✓ Compare the physical characteristics of comets, asteroids and meteors.
- ✓ Describe the different kinds of meteors.
- ✓ Explain the key milestones in space technology.
- ✓ Describe the use of various satellites in space
- ✓ Investigate how artificial satellites have improved our knowledge of space and their use in space research.
- ✓ Explain that how satellites tell us where we are

INTRODUCTION TO SPACE AND SATELLITES

✓ Define the term Space and Satellites.

Astronomy is a branch of science in which we study about the celestial objects of the universe such as stars, planets, solar system, galaxies, moons, asteroids and comets. In Astronomy, the word "Space" refers to the vacant area that exists between all celestial objects of the universe.

Do you know?

Celestial bodies These are naturally occurring objects exist in the universe. These are also called astronomical objects. Famous examples are Sun, moons, planets, stars, asteroids, comets and meteoroids etc.

Figure 12.2 Earth in outer space

A **satellite** is an object that revolves or circles around a larger celestial body such as a planet or a star. Satellites are generally classified into two basic types.

1. **Natural Satellites**: If a celestial (natural) body moves around another larger celestial body, it is called a **natural satellite**.
2. **Artificial Satellites**: If a human-made (un-natural) object moves around a celestial body, it is called an **artificial satellite**.

Just for Fun

Can I see distant objects on the sky using Binoculars? Like planet Mars.

There are several examples of Natural and Artificial satellites in space.

A well-known example of natural satellite is **Moon** the only natural satellite of Earth. There are many other artificial satellites orbiting Earth for various applications including Earth imaging, weather forecasting, tele-communication and so on.

Do you know?

First Step on the Moon

No human had ever set foot on any place in space until 1969 when two astronauts named Neil Armstrong and Buzz Aldrin took first step on the surface of Moon and spent about two and a half hours time there.

NATURAL SATELLITES

As described in the previous section that a natural satellite is a celestial body (or naturally occuring object) in space that revolves around another larger celestial body such as a planet or a star. There are about 173 known natural satellites orbiting different planets in the solar system.

Examples of Natural satellites of the Solar system

Think about a few examples of natural satellites of our solar system.

Let's start from Sun.

Do you know the name of natural satellites of Sun?

Figure 2.3: Natural and artificial satellites of earth

All the known eight planets (such as Earth, Mars, Mercury ...), minor planets (including dwarf planet Pluto), asteroids, comets, meteoroids and other small bodies of the solar system are astronomical objects that directly orbit the Sun and are called natural satellites of the sun.

Natural satellites of planets are called **moons**. All planets of the solar system except Venus and Mercury have moons.

Figure ... 4 The moon, earth and sun

Moon: The Earth's Natural Satellite

Moon is a celestial body orbiting Earth. It appears spherical in shape and is about one-fourth size (27%) of the Earth. In 1969, NASA's spaceflight named **Apollo 11** landed first humans on the Moon. Moon does not produce its own light like the Sun. It appears shiny because it reflects all the sunlight falling on it on to the Earth.

✓ Compare the physical characteristics of comets, asteroids and meteors

Asteroids

Asteroids are irregular shaped solid objects made up of rocks and metals. Asteroids come in various size ranges from a few meters up to several hundred Kilometers. There are millions of asteroids orbiting the Sun in outer space. The majority of asteroids exist in a region located between the orbits of Mars and Jupiter, called the **asteroid belt**. Asteroids are sometimes called minor planets or planetoids because they are the remnant pieces of planets left during the formation of solar system. Asteroids cannot be seen through our naked eyes, we need large telescopes to see them.

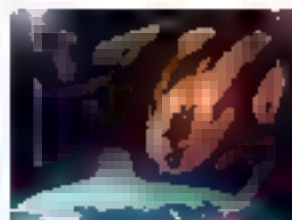



Figure 2.5 An Asteroid

Comets

Comets are the small broken pieces of ice, dust and gases found beyond the orbits of Neptune and Pluto in the solar system. Comets are also called dirty snowballs. Astronomers believe that comets like asteroids are also the remnants of planets left during the creation of our solar system.

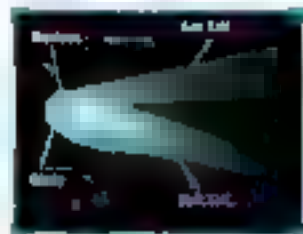



Figure 2.6 A comet

Comet looks like a long hair strand and consist of three main parts the **nucleus, coma and tail.** The nucleus of a comet is a cold rocky body. Comets revolve around Sun in highly elliptical orbit. At the first glance, comets and asteroids may appear very similar but the difference lies in the presence of Sun.

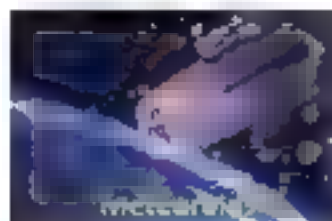
As a comet approaches Sun, coma (hazy cloud) and tail appears on its main body glows while asteroid remains unaffected. The tail of comet always point in the direction opposite to the sun. We can see comets occasionally during our life time because they spend most of the time in outer solar system.

What is Halley's comet?

Halley's comet is the only comet visible to the naked eye from Earth. It appears on the sky every 76 years. Last time it was seen in 1986. Next time it will be visible in 2062. Astronomers called it a short period comet because its period of revolution is in the range of tens of years. It was first observed in 240 BC.

Figure 12.7 Halley's comet

Meteoroids

Meteoroids are small rocky particles found to be floating in outer space. Most meteoroids are leftover pieces of comets and asteroids. When a high speed meteoroid enters into Earth's atmosphere, it heats up so much that it glows and appears like a bright streak of light on the sky called **meteors.** Meteors are also called fireballs or shooting stars.

Small sized meteors burn completely within a few seconds as they enter into the Earth's atmosphere. It is only their dust that reaches to the Earth, whereas large sized meteors do not burn completely. Such meteors fall on the surface of Earth in the form of small rocks. These half-burnt rocky pieces found on Earth are called **Meteoroids**.

ARTIFICIAL SATELLITES

- ✓ Define the terms artificial satellites and geostationary
- ✓ Describe the use of various satellites in space

Artificial satellites are human-made objects designed to place in an orbit around the Earth or other celestial bodies in the outer space. These satellites are sent into space through a powerful vehicles such as rocket.

Once a satellite is put into the orbit, it uses solar energy (energy from Sun) to perform work throughout its life time. Today there are so many artificial satellites operating in the space.

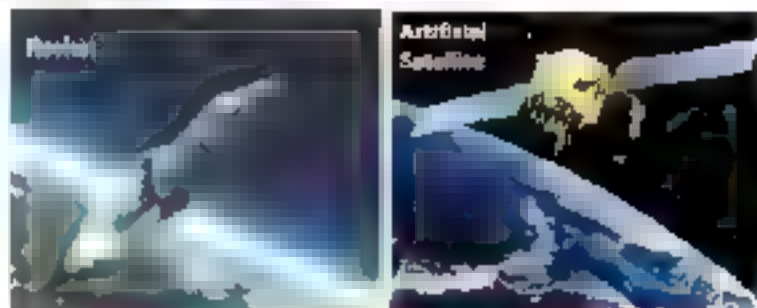



Figure 12.8: A rocket is used to launch an artificial satellite into orbit

Most of these artificial satellites are placed in orbits around the Earth. Generally, these satellites are flying in elliptical shaped orbits located at different distances from the surface of Earth. The well known applications of these satellites include Telecommunication, TV signal broadcasting, Earth imaging, weather forecasting and navigation.

PAKSAT-1R the first communication satellite of Pakistan launched in 2011 by [illegible]

Artificial satellites carry various instruments like cameras, antennas, electronic devices and signal transmitters etc, into the space. These satellites are tracked and monitored on Earth through special setups called **Ground Stations**. Ground stations use large dish antennas and computer labs to collect and process incoming satellite data.

Figure 12.9: Ground stations of artificial satellites

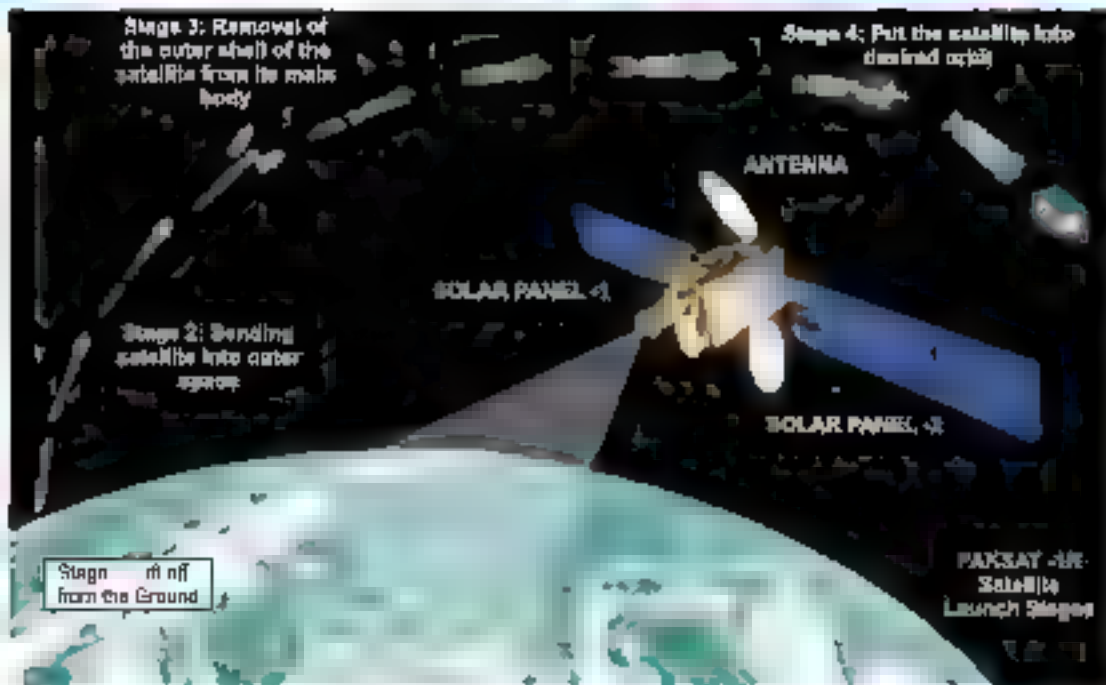



Figure 12.10: Launching of PAKSAT-1R satellite into space

Do you know?

Astronaut: Humans travel into the space for various explorations are called astronauts. Some astronauts have become famous for their achievements like Neil Armstrong, the first man set foot on the surface of Moon.

Space agencies are the organizations responsible to explore the outer space and its treasures for the benefit of mankind. In the past, only few countries had space research facilities. Today many countries are engaged in space related activities for their development.

Following is a list of some famous space agencies with their country name for your information.

(1) NASA	(USA)	(2) ESA	(Europe)
(3) RKA	(Russia)	(4) JAXA	(Japan)
(5) CNSA	(China)	(6) SUPARCO	(Pakistan)
(7) CNES	(France)	(8) ISRO	(India)
(9) ISA	(Iran)	(10) KARI	(Korea)

Types and uses of artificial satellites

Artificial satellites have been used for various applications since the time of their development. Today these satellites are widely used in almost all fields that make our life easier and better in many ways. On the basis of their uses artificial satellites can be classified into following types.

Do you know?

Geo-Stationary Satellites: The word Geo-Stationary is made up two words.
Geo means Earth and Stationary means not moving. The satellites flying in this orbit seems stationary to any object placed on Earth. The time period of this orbit is 24 hours.

Types of Satellites	Application	Examples
Weather Satellites	These satellites are used to provide latest information about atmosphere such as clouds and temperature of various regions of Earth.	GOES-8 (USA) & Meteo Sat (Europe) etc.
Communication Satellites	These satellites are used to provide fast and accurate communication services all over the world such as radio and TV signals broadcasting, audio and video calling and text messaging or emailing, etc.	Americom (USA), Pak Sat-1R (Pakistan), InSat (India) & AsiaSat-8 (USA), etc.
Earth Observation Satellites	These satellites use camera to take photographs of the Earth from space that are used to map cities, observe crops and provide useful data about other natural disasters such as floods, earthquakes, forest fires and storms etc.	Land Sat (USA), Spot (France), Geo Eye (USA) & World View (USA), etc.
Navigation Satellites	These satellites are used to locate the exact position of any object such as humans, devices, vehicles (including cars, ships and aeroplanes) for search and rescue purposes. The Global Positioning System (GPS) is one of the famous application of navigation satellites.	GPS (USA)
Scientific Satellites	These satellites are used for scientific research and space exploration studies. These satellites collect information about the Sun, planets, moons and other celestial objects of our solar system and the universe.	Hubble Space Telescope (HST) & International Space Station (ISS) etc.

GLOBAL POSITIONING SYSTEM (GPS)-

✔ Explain that how satellites tell us where we are

Figure 12.13: Parts of GPS

Long time ago, humans used sun, stars and moon to find their positions and ways. Then in around 1000 AD, the invention of compass made this job easier, but it was useless if one did not have a paper map in hand.

Today, satellite technology has made it possible to locate the exact and latest position of humans and other objects (like car, ship or aircraft etc.) anywhere around the world using GPS. The GPS is a space-based navigation (direction finding) system that is commonly used to search a desirable place on Earth. It is sometimes also used to provide rescue services around the world.

GPS consists of three main parts: satellites, receiver and ground station. GPS works by sending signals through a group of satellites all over the world. GPS receivers collect these signals and calculate exact position of object on Earth. Ground stations use radars to detect and track objects or humans.

Today, GPS is easily accessible to everyone through modern mobile phones. Other objects like car, ship and aircraft also contains GPS receiver devices for their tracking. Mountain climbers or tourists also take GPS receivers with them for safety or rescue purposes.

GPS Search and Rescue Application

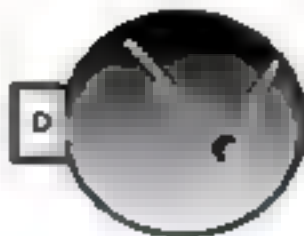
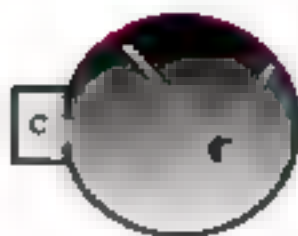
In the picture, Sana helped her friend Amna who fell down the hill using hand-held GPS device. The ground station found their location via device signals and a helicopter reached there in a short time to rescue them.

Figure 12.14: GPS used for rescue

Make your own Artificial Satellite Model

> This is a scissor cutting activity so print it on a card sheet with blank back.

Material Required

- White card sheet
- Wooden board / Table
- Paper Glue
- A Scissor and a paper cutter

1 Satellite Dish Antennas
(Used to send and receive information from Earth)

2 Solar Panels
(Used to provide power / Fuel to the satellite)

Figure 12.11: The Tomb of Quaid-e-Azam at Karachi (As seen from space - Satellite view)

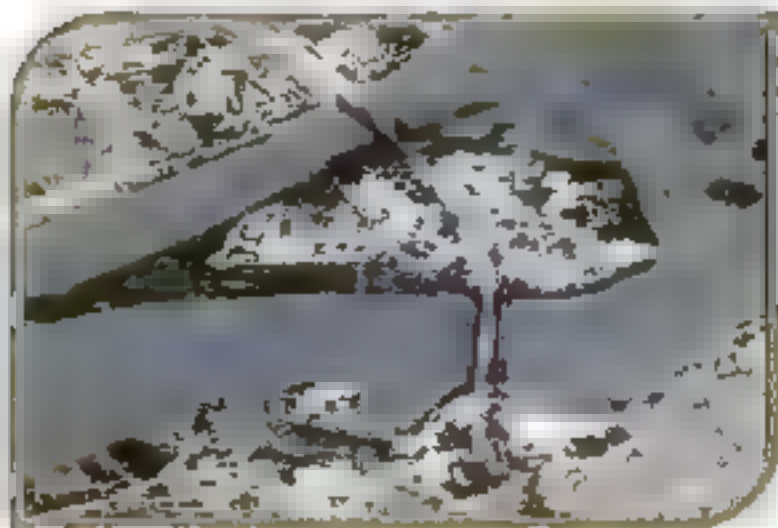



Figure 12.12: Ayub Railway Bridge over Indus River at Sukkur
(As seen from space - Satellite view)

Review Questions

1. Complete the following sentences using the words given below

Meteors, Mars, asteorids, natural, global, Jupiter, Sun, Geo-stationary, photographs, navigation.

(a) Moon is the __________ satellite of Earth.

(b) Most of the __________ lies between the orbits of __________ and __________

(c) The time period of __________ orbit is 24 hours.

(d) __________ are called shooting stars.

(e) __________ satellites are used to locate position of ships, aircrafts and even automobiles

(f) The tail of comet appears as it passes near to the __________

(g) In the word GPS, letter G stands for __________

(h) Earth observation satellites are used to take __________ of Earth.

(i) __________ country launched first artificial satellite in Space

2. Mark which of the following sentences are true (T) or false (F)

(a) Navigation satellites are used to broadcast TV signals. T/F

(b) Artificial satellites are man-made objects. T/F

(c) Moon is the only natural satellite of our solar system. T/F

(d) Meteoroids and asteroids are made up of rocks T/F

(e) Natural satellites are non-celestial bodies T/F

(f) Asteroids are also called minor-planets. T/F

(g) Landsat is the name of satellite launched by Pakistan. T/F

(h) Comets appear as a bright streak of light on the sky. T/F

3 Give short answers to the following questions.

(a) Define Satellite and name its types?
(b) Write down the name of natural satellites of Sun?
(c) What is comet and how it is different from asteroid?
(d) How can we locate the position of an object on Earth using artificial satellite?
(e) In how many types an artificial satellite can be classified on the basis of their uses? Give their names only.

4 Carefully identify the marked objects of the following picture and put the correct answer in the boxes using words given below.

Meteor, Meteoroid, Asteroid belt, Meteorite

5. Circle the correct answers of the following questions:

i. Which of the following is not a natural satellite?

(a) Moon

(b) Sputnik-1

(c) Saturn

(d) Comet

ii. Earth observation satellites are used for:

(a) TV signal broadcasting

(b) Mapping

(c) Telecommunication

(d) Space exploration

iii. Global Positioning System (GPS) is used to:

(a) Launch artificial satellites.

(b) Provide weather forecasting

(c) Identify location of objects on Earth

(d) Collect information about planets and Sun.

6.Mark "√" in the correct box to indicate characteristics of Asteroids, Comets and Meteors

Characteristics	Asteroid	Comet	Meteor
Appears as a streak of light on the sky			
Frozen ball of dust or dirty snowball			
Visible on the sky through our naked eye			
Made up of rock			
Looks like a long hair star			
Orbits the Sun			
Halley is one example of			
Remnants or leftover pieces of planets			
Often called Shooting stars			
Usually burns up when enters into Earth atmosphere			
Tail appears as it gets closer to Sun			
Mainly found between orbits of Mars and Jupiter			
Sometimes appear in the form of shower on sky			
Take so many years to complete its one orbit			

7.See the following pictures carefully and label their names

Steps:

- Carefully cut-out pictures (1,2 and 3) from the sheets using scissor or a paper cutter.

- Take picture 3 and use paper cutter to mark small cuts at points A,B,C and D.

- Now match the marked points of different parts of satellite given in pictures 1 and 2 with picture 3 and join them (use glue if required) with the main body of satellite through out ends.
- Now make folds at the dashed lines given in picture 3 to get the shape of hexagonal structure.
- Finally use glue to join all the ends of satellite together, now your satellite is ready to launch.

After assembling all the pieces, the final satellite model looks like:

C

A

D

B

3 Main satellite body